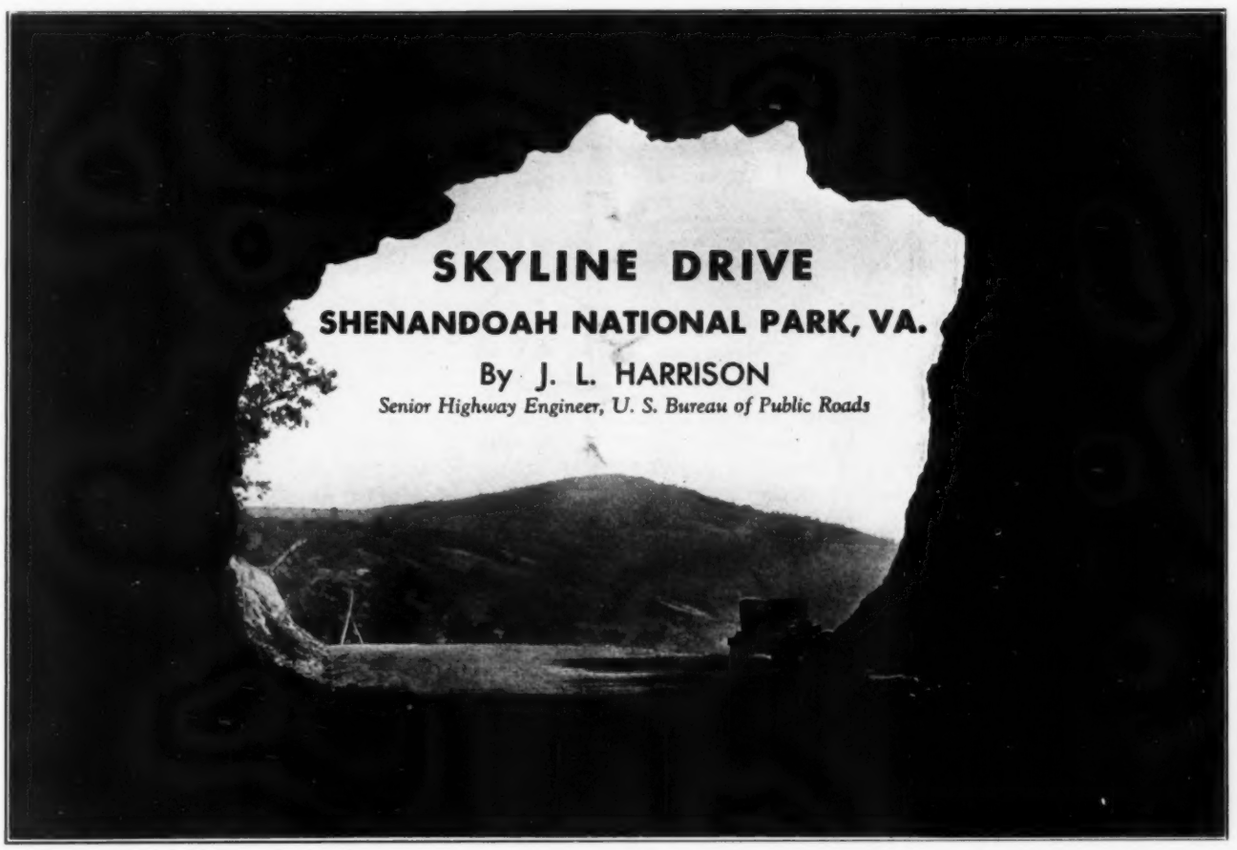
ROADS And STREETS
Vol. LXXVII Number 12
A GILLETTE PUBLICATION
ESTABLISHED 1906

Through the North Portal of Tunnel. Skyline Drive, Shenandoah National Park, Va.

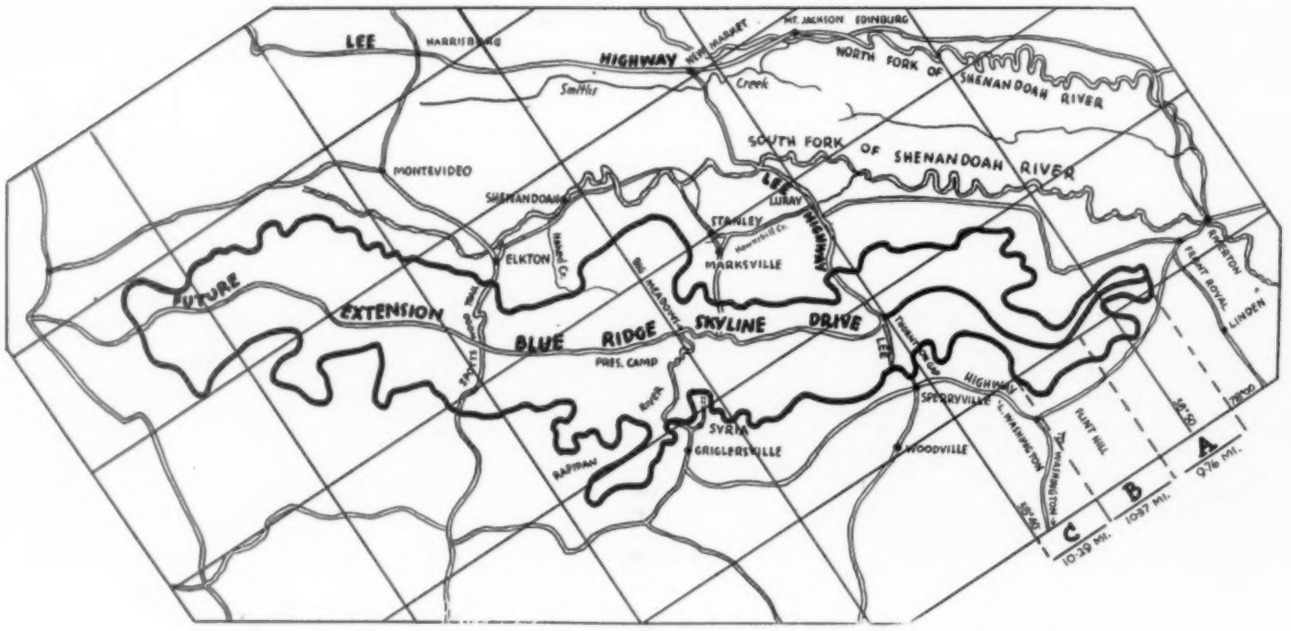


A New Standard for the Development of Highway Accessibility to Mountain Scenery

FOR a good many years the Federal Government has interested itself in the acquisition and preservation of areas of special scenic interest. Most of these areas, known as national parks, have been in the Far West where special natural wonders or scenic attractions early stimulated such interest that a demand for their nationalization developed. Of these the Yellowstone and Yosemite Parks have appealed most strongly to popular imagination and are no doubt the best known. To a certain extent this is due to the special features these parks contain but it is perhaps due even more to the fact that these features have been made so readily accessible by the construction of roads and trails that it is possible for all who desire to do so to enter these parks and travel about in them, there to enjoy the beauties they contain.

There are, of course, many other national parks and these, too, are being made accessible in this same way as is quite essential for no matter how beautiful a spot may be, it has small value to the public at large until it is placed at their ready disposal. So it is but natural that the construction of roads and trails in it should at once present itself for consideration when the acquisition of a new national park is contemplated. Thus it transpired that when it was proposed that the Federal Government accept the area known as the Shenandoah National Park and in so doing that it preserve the natural forests and the scenic beauties this area contains, one of the first matters which had to be considered was that of making these available to the public.

The manner of reaching this objective was turned over to the Bureau of Public Roads for solution. As a



Map Showing Position of Shenandoah National Park and Location of Skyline Drive

problem it sounds simple enough—a rough wooded country some 80 miles long and averaging some 10 miles wide, excellent eastern mountain scenery, but nothing particularly bizarre about it—wanted, accessibility and attractiveness—preferably something that will lead the public to take advantage of the scenic beauties the park provides and in so doing acquire familiarity with eastern mountain country and with the things which have made such country attractive to so many people.

A New Thought in Park Development—The solution was the Skyline Drive, the design of which offers a new thought in park development—a thought so unique that it may fairly be said to establish a new standard for the development of accessibility to mountain scenery. There is no other mountain drive like it anywhere else in the world, although another is now under construction in the Big Smoky Mountains.

Photo by Courtesy U. S. Bureau of Public Roads
Trimming Slopes on Skyline Drive, Shenandoah National Park, Virginia

The basic idea which underlies the design of the Skyline Drive is that the most attractive mountain scenes are had by getting above the surrounding country so that one looks down onto it and at the same time obtains distance as a major factor in the view. This is the effect the lovers of nature climb high mountains to obtain; the effect which causes the less actively inclined among us to pause as we drive through mountain passes to enjoy the grandeur and the vastness of the scenes they present to view. Unimaginative indeed is the man who does not obtain a thrill from such scenes—who does not count it a pleasanter day because he has looked on one of them.

But if a thrill is to be had from a mountain-top or even from a mountain pass—to develop mountain scenery why not build along the tops of the mountains and multiply the number of these thrills indefinitely? Difficult? Certainly. Expensive? No doubt. But thrills? Ah, there's the point. What thrills there would be in driving for mile after mile on the backbone of the world!

Skyline Drive—A Road Along the Top of Mountains—This, briefly, is the daring conception which underlies the design and the construction of the Skyline Drive—a road along the top of a mountain ridge—a road along which the view is always far flung—a road along which one thrill follows another in endless succession!

That the idea is correct has already had ample proof. Thousands have traveled long distances to drive over this parkway. Many have come again and again to enjoy the marvelous scenery it offers. Indeed, so popular has this drive proved that it is already nationally famous. So intriguing is it that, merely to drive over it, it now seems probable that more people will visit the Shenandoah National Park next year than will visit all of the other national parks combined! No greater compliment to the virtue of a new idea is possible.

Some Design Considerations—Passing to the more prosaic aspects of this drive, one thought deserves a word of comment. In the design of any road or trail that is to be constructed within a national park or within

Photo by Courtesy U. S. Bureau of Public Roads
Road Ascending Pinnacle Mountain, Shenandoah National Park, Va.

any other park in which the natural scenic beauties are to be preserved, it is necessary so to arrange the roadway that it does not mark or mar the landscape. To obtain this result roads are, as far as this is possible, laid on the floors of the valleys. Where this is not possible, they must be screened behind trees and shrubbery, or behind cliffs or, if it is necessary to build in the open, the cuts and the fills must be so treated that they will shortly become as inconspicuous as it is possible to make them.

In the design of the Skyline Drive the fact of its location along the crest of the ridge eliminated some of the usual problems in this field for the objective is always to obtain a view in which the highway itself does not appear. In this respect the relation of the highway to the preservation of the scenic features it is built to make available is much the same as the relationship which exists when the floor of a valley is used as an approach to imposing scenes. This is of some importance in considering highway locations of this sort for the crest of any mountain range is a pretty rough, ragged thing and if a road is to be built along it at all there must be some skirting of the highest points and the construction of some fills along hog backs or the resulting gradients are bound to be prohibitive.

Many Problems in the Design—At that the design of any ridge road offers a good many problems. As rock predominates the cuts are not, as a rule, a serious problem though occasionally the face of rock cliffs is so steep that tunnels are to be preferred to open cuts. In the construction of the Skyline Drive a cliff of this sort near the north end caused the construction of a 300-ft. tunnel. A somewhat shattered cliff surface tended to make an open cut undesirable and as the use of an open cut would have required the use of several short radius curves, it was deemed preferable to use a tunnel. Conditions of this sort are likely to occur on any project of this sort.

One of the major problems in work of this character is the construction of the fills. Toward the top of a mountain range the natural slopes tend to become rather steep. Often they are sharper than the angle of repose at which loose material will stand. Some of the hog backs over which the road must pass will be quite narrow, occasionally narrower than the roadway it is desirable to build over them. Quite often their sides are steep. For these reasons, it is to be expected that retaining walls will be a conspicuous feature in the design of roads of this character and in this particular the Skyline Drive was no exception to the general rule. True enough, rock usually is available in ample quantity but even then

Photo by Courtesy U. S. Bureau of Public Roads
Road Drag in Operation on Skyline Drive, Shenandoh National Park

Photo by Courtesy U. S. Bureau of Public Roads
Applying Road Oil on Skyline Drive

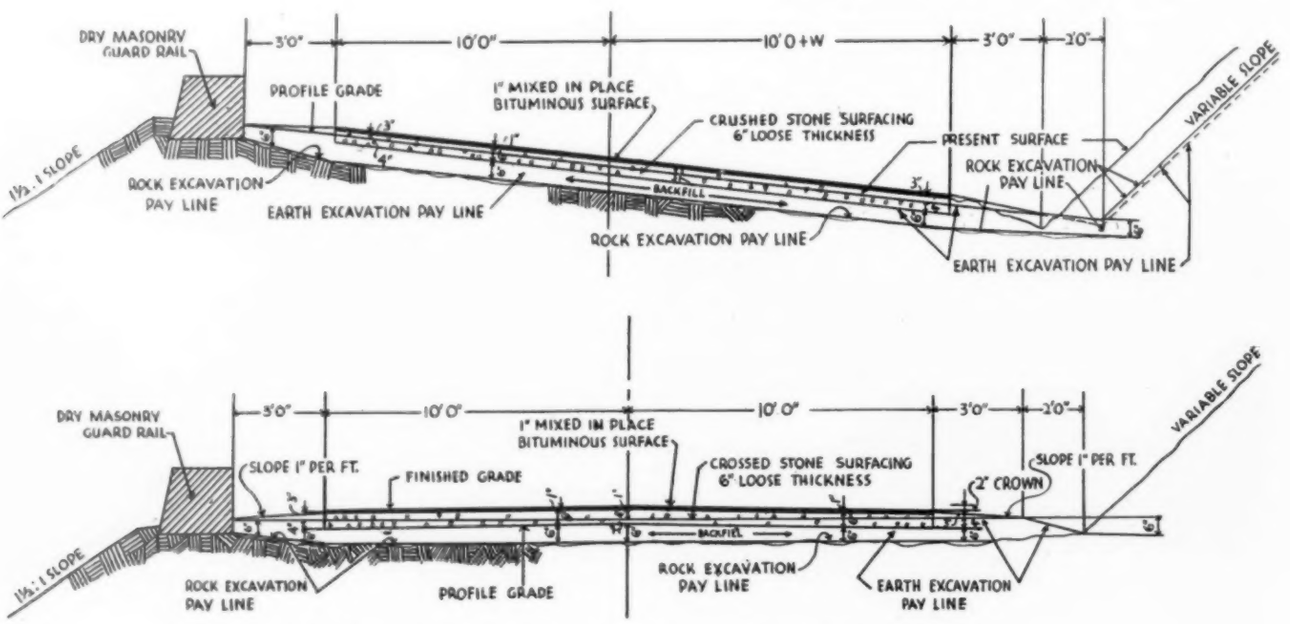
Photo by Courtesy U. S. Bureau of Public Roads

Lee Highway from North Portal of Tunnel, Looking Northeast, Descending to Sperryville, Va.

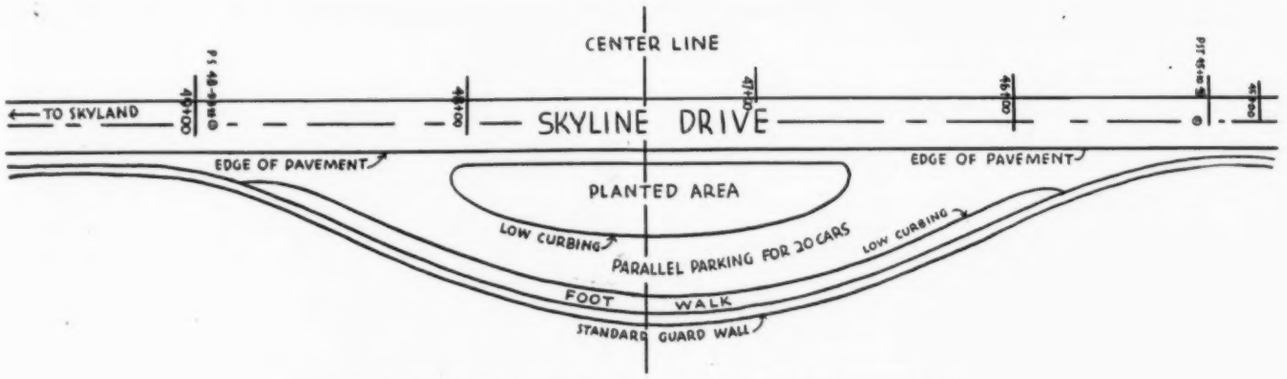
the expense of placing it in substantial rubble masonry retaining walls is considerable.

Side Hill Construction—The fact that at the top of a mountain range natural slopes are pretty apt to be steep also affects the design of side hill cuts, and in work of this character through cuts are, for obvious reasons, pretty definitely out of the question. In ordinary locations, where a road is carried around a hill, the usual side hill construction places the roadway partly in cut and partly on fill. This is economical and quite satisfactory as long as the natural slope of the ground is materially less than the slope at which fills will stand. But when the natural slopes are about as steep as or steeper than the angle of repose taken by loose material, it becomes quite undesirable to use a cut and fill section with the result that as far as possible side hill work must be done in cut only. Naturally cases arise where it is necessary to use a cut and fill section, but in such cases it is at least commonly necessary to use retaining walls to confine the toe of the fill slope within reasonable bounds.

The protection of the equipment that is to be used also tends to encourage construction on the bench rather than on a cut and fill section. Contractors do not like to take the risk of working heavy equipment on a narrow bench



Typical Pavement Sections: Above, on Curve or Spirial. Below, on Tangent



Parking Overlook on Skyline Drive, Shenandoah National Park

on side hill work in mountain country. Often it is not safe to work it off the bench as the ground is not solid enough. If not positively unsafe, a narrow bench is pretty apt to slow down operations. Placing the whole width of the highway on the bench rather than placing it on a cut and fill section, therefore, tends to facilitate construction as well as to improve the stability of the finished structure, with the quite general result that, wherever this design is at all practical, it is desirable to use it on work of this character.

For obvious reasons drainage structures are a minor problem in any work done along a mountain ridge. The Skyline Drive was no exception to this rule. A few small culverts to handle the run-off that accumulates in the gulleys which mark the sides of the knobs that form the peaks of the ridge, are all that were required. Masonry headwalls are the rule—partly because of the expense of other types of construction—partly because of their pleasing appearance.

The Pavement—This drive is being surfaced with macadam over which a mixed-in-place top is being laid. The stone for the surfacing is quarried and crushed at various points along the drive where excellent rock for this purpose is to be had. Nothing new or unusual is involved in this aspect of the Skyline Drive, although the fact should perhaps be noted that on work of this character it is necessary to limit the selection of quarry sites to points where the recovery of rock for surfacing operations will not permanently mar the landscape and somewhat to govern the quarrying operations with this same end in view.

The pavement is 20 ft. wide and 3-ft. shoulders are used. Rubble gutters, grouted, are used wherever required.

Gradients and Curves—As to the generalia of design, notation should also be made of the fact that if any highway such as the Skyline Drive is to be safe and saatisfactory, beside adequate width it must have reasonable gradients, adequate vertical curves at changes in gradient, a thoroughly safe minimum radius of curvature, proper side protection and frequent parking places from which the more imposing views may be enjoyed at leisure without obstructing traffic on the drive. All of these matters have been given careful attention in the development of this drive. With minor exceptions, gradients have been held under 6 per cent. Long vertical curves have been used at changes in gradient and in spite of the extremely difficult nature of the terrain, the radius of curvature has with minor exceptions been held above 250 feet. Heavy masonry guard rails are being erected wherever required.

Parking Overlooks—The facilities which have been provided for stopping at points from which particularly attractive views are to be had, are of interest. These parking overlooks of which there are quite a number along the more than 34 miles of drive now open to the

Photo by Courtesy U. S. Bureau of Public Roads

Stone Guard Rail on Lee Highway

public provide space from which the view may be enjoyed at leisure and quite unobstructed by the passing traffic. The designs are worked out to fit the spot the overlook is to occupy. Overlooks add greatly to the pleasure to be had from a road of this sort for they promote a leisurely attention to the scenery it is built to make accessible.

To provide a satisfactory view from these overlooks and at other places along the road where it is desirable to do so, trees which would otherwise obstruct the view are either removed entirely or so trimmed that they add to the beauty of the drive without obstructing the view Work of this sort must be carefully done for its is quite undesirable that the land along the road present a denuded appearance and equally undesirable that the view be restricted by leaving too many trees. The work of trimming trees, planting new trees and shrubs where needed, taking out those which must be removed—in short, all matters involving the beautification of the roadway and the land adjacent to it—are under the constant supervision of an expert in this line of work.

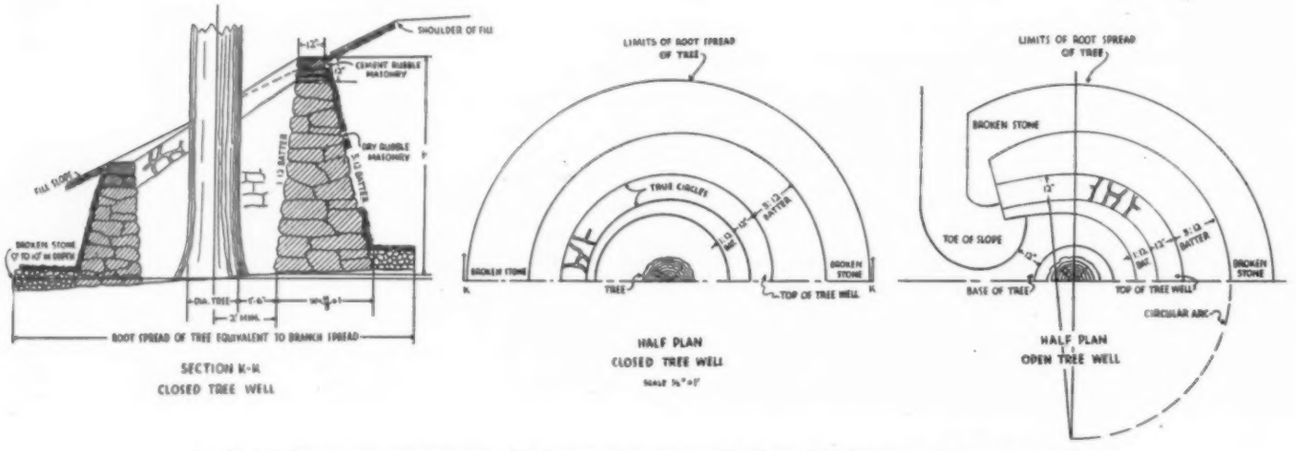
Protection of Valuable Trees—An interesting phase of the work of preserving the natural beauty of the land closely adjacent to the highway is to be observed in the protection of the valuable trees which are within the area that will be covered by the slopes of the roadway embankments. Covering any considerable part of the trunk of a tree is likely eventually to kill it. Rubble wells are, therefore, built around such trees to give their trunks necessary air.

Photo by Courtesy U. S. Bureau of Public Roads
North Portal of Tunnel on Skyline Highway

Excavating for a Side Hill Cut

The construction of a road such as the Skyline Drive offers no particularly unusual problems. The elevation of this road, most of it lies at elevations more than 3,000 ft. above sea level with elevation of from 3,300 ft. to 3,600 ft. frequently occurring, does not much affect the efficiency either of men or of animals.

Excavation quantities are balanced as on other work of this character. No problem is encountered here except that where fills are confined within retaining walls, these must be built before the fills can be laid down, a fact which sometimes offers a problem in the movement of the stone for the retaining walls. At places water, too, must be hauled for mixing mortar. Also, more than ordinary care is required on the part of the contractor that in blasting, rock is not thrown around to litter up the land bordering the roadway, that all work is neatly done and that nothing unsightly is allowed to remain on or along the drive. These, however, are minor matters from the operating standpoint. Aside from such matters as these, construction practices have been normal and the results about what would have been expected under usual conditions.



Section of Closed Tree Well; Half Plan of Closed Tree Well, and Half Plan of Open Tree Well

VEHICLE POWER REQUIREMENTS As Affected by Roadway Surface

New Measurements Permit Closer Solution of Highway Problems

RECENT tests conducted by the Iowa Engineering Experiment Station supply much-needed data as to the effects of various types and conditions of road surfaces on the power requirements and gasoline consumption of vehicles using them. The tests also disclose important facts regarding air resistance and the effects of grades.

The fundamental economic problem of providing unit transportation at minimum cost is thus brought measurably nearer solution. In fact, with the data now available, the engineer can choose his type of pavement much more intelligently than heretofore. Also he can better determine what sums to expend for maintenance. When certain supplementary tests have been made with representative types of motor vehicles on various types and conditions of roadways, the economic factors of highway location, design, and maintenance will be on a basis comparing favorably with the factors in railway engineering. The report of the Iowa experiments says nothing of plans for such additional work, but their obvious importance should lead to their undertaking by one agency or another—possibly, because of the expense, by several agencies.

A full report of these experiments is given in Bulletin 119, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa, under date of Aug. 1, 1934. The title is "Tractive Resistance as Related to Roadway Surfaces and Motor Vehicle Operation." R. G. Paustian, Instructor of Civil Engineering, is the author. The bulletin contains 64 pages, and is well illustrated with cuts and diagrams. Many references are made to previous studies in the same field by Prof. T. R. Agg and others. The following abstract is given.

Abstract.—"An analysis of motor vehicle tractive resistance and its separation into rolling resistance and air resistance is given. The relative merits of towing, decelerating, coasting, and direct methods of measuring tractive resistance are discussed, followed by a complete description of the gas-electric drive test car used in this investigation, its equipment, and the direct testing procedure employed. The explanations, tables, and figures present results of laboratory calibrations of the test car, of road tests showing the effect of road surfaces on power requirements, gasoline consumption, and tractive resistance, and of the effect of impact and wind on resistance. The power requirements and gasoline consumption required on grades are also discussed. The effect of speed and air temperature on tire temperature, and the effect of speed on the rolling radius of the tires are shown. A partial bibliography is appended."

The experiments covered a period of approximately three years, during which more than 2,000 direct measurements of tractive resistance were made on some 30 sections of road surfaces.

Basic Factors Developed.—Quoting from the bulletin: "Of primary importance is the question of the effects of roadway surfaces upon motor vehicle operating costs. Since to determine these effects for all types of vehicles under various driving conditions would be impractical and prohibitively costly, recourse is had to a single test car to establish certain inherent characteristics of road surfaces, thus developing basic factors applicable to other vehicles. Such procedure is logical and produces data that one can use with assurance instead of resorting to the assumptions that otherwise would have to be made."

Vehicle Costs Exceed Road Costs.—The importance of an accurate knowledge of the effects of different types of road on vehicle operation is emphasized by pointing out that vehicle operating costs comprise more than two-thirds of the total cost of highway transportation.

Following are additional quotations from Mr. Paustian's paper, together with notes or synopses on portions which it is impractical to quote here at length.

Definition.—"(1) *Tractive resistance* 'is usually interpreted to mean a hypothetical force whose line of action is parallel to the road surface and the longitudinal axis of the vehicle, and whose magnitude is equal to the summation of the components in that line of all external forces acting on the vehicle when it is traveling on a level road surface.*' The term *total resistance,* as used in this bulletin, is synonymous with tractive resistance.

(2) *Rolling resistance* is that part of tractive resistance due to the resistances in the running gear and tires of the vehicle and the deformation and irregularity of the road surface.

(3) *Air resistance* is that part of tractive resistance due to the retarding effect of the air.

(4) *Density resistance* is that part of air resistance due to the turbulent whirls and eddies set up as the vehicle passes through the air.

(5) *Viscosity resistance* is that part of air resistance attributed to friction between the body of the vehicle and the surrounding air.

(6) *Impact resistance* is the retarding force due to irregularities (roughness) of the roadway surface.

(7) *Grade resistance* is due to the component of the weight of the vehicle down the grade."

"The values of resistance are usually expressed as the total resistance in pounds for the entire vehicle weight, but in the case of tractive resistance this item is expressed also in pounds per ton of vehicle weight. In comparing the latter values with those of other experiments, it should be remembered that the results of this investigation represent those obtained with a single test car—an

*T. R. Agg: "Tractive resistance of automobiles and coefficients of friction of pneumatic tires." 1928.

automobile perhaps twice as heavy as the average."

Rolling Resistance.—"That part of tractive resistance termed rolling resistance is made up of many small resistances that may be classified as due to:

(1) Friction in the wheel bearings.

(2) Friction in the tire walls and tread as they flex when rolling along the road surface (tire deformation).

(3) Deformation of the road surface.

(4) Irregularities of the road surface (impact resistance).

(5) Churning of the air by the wheels.

"The aggregate of these five items is the resistance in the running gear of the vehicle, and it is applicable alike to automobile, truck, or trailer. However, it is often more convenient to include also the retarding forces due to three additional items of friction to be found in the:

(6) Propeller shaft and its universal joints.

(7) Differential gearing and bearings.

(8) Rear axle bearings.

The total rolling resistance used is made up of these eight items.

"To add further to the complexities of the problem, each of these items is affected by one or more variables, some of which are: Type of tire, tire material, tire pressure, condition of road surface, road surface material, road crown, road curvature, grade, wind, speed, and lubricants. For the condition that exists when an individual test car is driven over a straight, smooth, level, and unyielding road surface at a given air temperature in the absence of wind, it is obvious that the only variable that need be considered is speed."

Air Resistance.—In a very interesting discussion of air resistance, on the basis both of these tests and others, it is stated that at a speed of 60 miles per hour, air resistance makes up more than 60 per cent of total resistance. Air resistance is found to vary approximately as the square of the velocity—probably according to an exponent between 1.80 and 2.00.

Tractive Resistance Measurements.—"As a result of tractive resistance by Agg, Lockwood, Lay and others, it is possible to classify the various methods of measuring tractive resistance as indirect and direct.

"By the first method, the values of tractive resistance are obtained by calculation and interpretation of data secured while the vehicle is coasting or otherwise not operating under its own power. The tests included in this classification are those in which the vehicle (1) is towed, (2) coasts on a level grade, or (3) coasts down a grade. Direct measurements of tractive resistance are made while the vehicle is operating under its own power.

"The importance of the effect of changes in air temperature can hardly be over-estimated, and to be comparable, all tests should be made at approximately the same temperature, or the proper correction factor applied."

These temperature effects, and also the effects of changes in wind velocity are discussed in the latter part of the report, but are not quoted here. It is noted that tractive resistance measurements are changed by even a light head or tail wind.

Of the three indirect methods of measuring tractive resistance, the first two—towing and coasting on a level grade (also designated "deceleration method")—were rejected as unsatisfactory, although the second was tried several times in the course of the tests.

Coasting Method.—Coasting down a uniform grade gave satisfactory measurements of tractive resistance.

"Acting down the grade is the component of the weight of the vehicle, as opposed to rolling and air resistance acting up the grade. If the grade is long enough, the vehicle will reach a constant speed at which the forces aiding motion and those opposing motion of the vehicle are equal. In other words, the component of the weight of a vehicle is a measurement of the total rolling and air resistance at the constant coasting speed.

"The use of the coasting method, therefore, necessitates having a grade of sufficient length to enable the vehicle to reach its coasting speed. Using several different grades will give values of tractive resistance at various coasting speeds. The coasting method was used to check the results of direct measurement tests."

Direct Measurement.—"The advantages of direct measurements lie in the fact that they are made when the vehicle is operating under its own power.

"Actual determinations of the forces resisting motion of a vehicle on the road are made by measuring the power required to overcome these resistances. This is accomplished, either mechanically or electrically, by noting the power or the torque required to turn the wheels and thus move the vehicle. Mechanical measurements of the torque at the driveshaft, at the rear axle, or at the rear wheels, have been the subject of researches which in the main, have not been successful. This has been due, chiefly, to the difficulty of measuring small torques and forces under ordinary operating conditions.

"In the present investigation, the test car was driven by an electric motor connected, through the driveshaft, to the rear wheels. The current needed to drive this motor was furnished by a generator, the armature of which was connected to the flywheel of the gasoline engine of the car.

"If the power required to drive a vehicle is known it can be shown that this power is used in overcoming a force, the magnitude of which is given by the common expression,

$$R_T = \frac{375\,P}{V}, \text{ or } P = \frac{R_T V}{375}, \qquad [1]$$

in which R_T = the total resistance to motion of the vehicle in pounds, P = the horsepower required to overcome R_T, and V = the vehicle speed in miles per hour. The value of R_T is a measure of the magnitude of tractive resistance.

"There are some difficulties attendant upon the measurement of tractive resistance by this electrical method. The first and perhaps most objectionable feature, is the weight of the electrical equipment. For instance, the weight of the generator, motor, and control equipment used in the present investigation was well over 1,000 pounds. The high first cost, the difficulty of installing such equipment, and the subsequent inability to transfer it readily from one vehicle to another are other items worthy of serious consideration. Then too, since a test car thus equipped does not have a clutch or transmission its operation is different from that of the ordinary automobile."

Equipment and Test Procedure.—"To make a complete analysis of tractive resistance, the test car should be designed and constructed to give an accurate and unfailing record of the car's performance. Such data, of course, should be paralleled by records of gasoline consumption. The foregoing were the brief specifications in mind when it was decided to use a gas-electric drive vehicle. To a large extent, these specifications account for the consistency and accuracy of the final results.

"A Model 314 Cadillac coach was equipped with a gas-electric drive and used as a test car. The electric drive which replaced the regular transmission consisted of a shunt-wound direct current generator, a series-

wound direct current motor, and the necessary control equipment.

"Since the armature of the generator was bolted to the flywheel, its speed was the same as that of the gasoline engine which, in turn, was controlled by the movement of the accelerator pedal. Electrical energy was thus supplied to the driving motor in accordance with the speed of the gasoline engine and the power required to drive the rear wheels.

"The operation of the test car was much the same as that of the ordinary automobile, except there was no clutch, the speed being controlled by using the accelerator pedal. With the gasoline engine at full throttle, the car traveled about 50 miles per hour, except when resistance was cut into the generator field circuit. This resistance decreased the load on the generator, allowed the gasoline engine to speed up, and made more power available; the top speed of the car was then about 70 miles per hour.

"The total weight of the test car, including the weight of a driver and two observers, was approximately 6,300 pounds. The tires used were 33-inch by 6.75-inch heavy duty balloons, which were inflated to a pressure of 45 pounds per square inch."

Instruments.—"The instruments used in measuring power output, gasoline consumption, speed, and time are shown on the instrument panel in Fig. 1. They consisted of two gasoline gages (burettes calibrated to 0.005 gallon), a voltmeter and ammeter to indicate power output, a photographic timer used as a half-second timing device, and a voltmeter connected to a tachometer on the front wheel. The latter gave an accurate indication of the speed of the car. Shown below these instruments are the lever which controlled the filling and emptying of the gasoline gages, the switches that controlled the lighting equipment, and a relay wired into the timing circuit with the photographic timer.

"These instruments were supplemented by a space-time recorder of the usual paper ribbon type that was driven by a controlled variable speed motor. . . . From the paper ribbon record it was possible to secure values of actual speed and of front and rear wheel revolutions. These, tied in with the current readings and gasoline consumption records furnished by the instruments on the panel, gave a complete and accurate record of the car's performance."

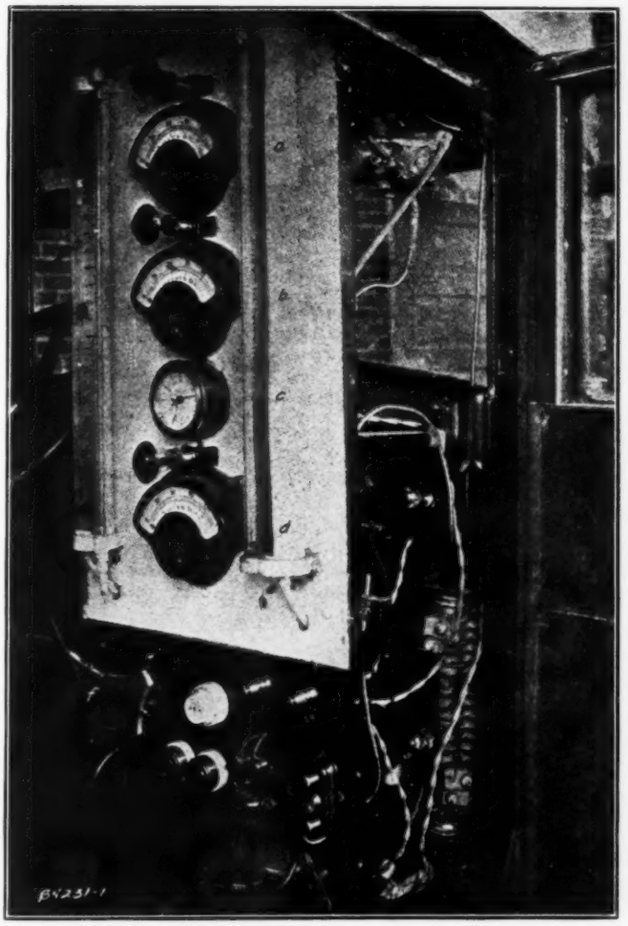


Fig. 1.—Instrument Panel Showing (a) Voltmeter, (b) Ammeter, (c) Timer, (d) Speed Indicator, (e) Gasoline Gages, (f) Lever Controlling Emptying and Filling of Gasoline Gages, (g) Switches for Lighting Equipment, and (h) Timing Relay for Space-Time Recorder.

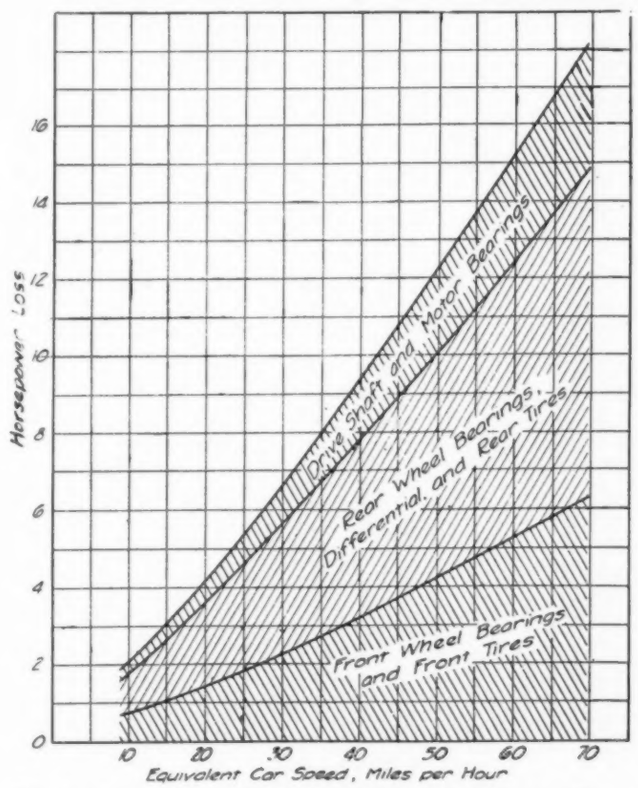


Fig. 2.—Power Losses in Moving Parts of Test Car as Shown by Dynamometer Tests.

Calibration of Test Car.—Laboratory calibration of the test car was made to measure rolling resistance at various speeds and to determine the efficiency of motor and driving assembly. All tests for this purpose were made on a chassis dynamometer. The instruments were correlated with "driveshaft horsepower," which term is used to designate the actual amount of power transmitted by the electric motor to the shaft that drove the rear wheels of the car. Obviously the results of the tests can apply only relatively to any car other than the test car.

Road Tests.—"The procedure used in making actual road tests involved two different methods of observing and recording the data. In the first, two observers recorded the reading of the meters, and gages. These same readings, in the other method, were obtained by photographing the instrument panel.

"For the majority of tests, four runs, two in each direction, over courses ranging from ¼ to 1 mile in length, comprised one series of runs at a given speed. In most cases, the test courses were straight, level and uniform

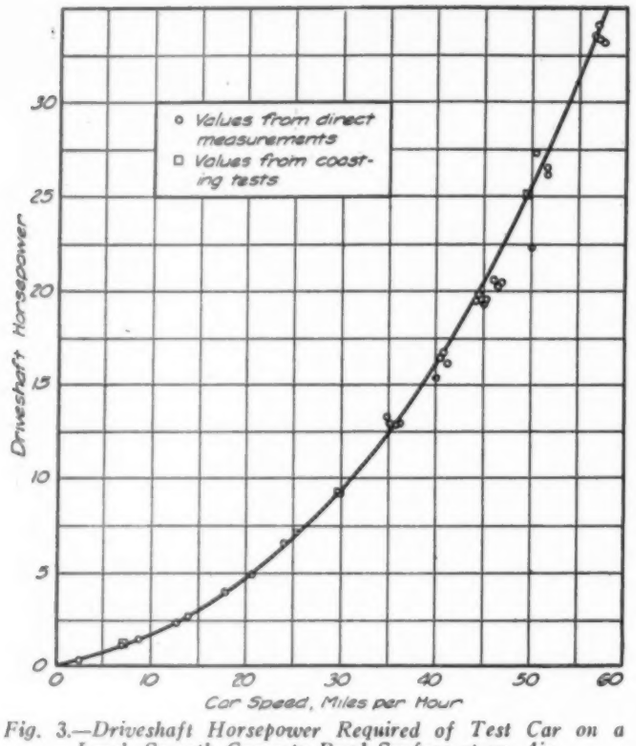


Fig. 3.—Driveshaft Horsepower Required of Test Car on a Level, Smooth Concrete Road Surface at an Air Temperature of 70° F.

in surface condition. Runs were made at speedometer readings of 10, 20, 30, 40, and 50 miles per hour, corresponding to actual speeds of 13, 24, 35, 46, and 57 miles per hour. A check on tire pressures, tire temperatures, air temperature, and wind velocity was made at the end of each series of runs.

"Most of the test courses were located in the vicinity of Ames, though some were in Indiana and Minnesota."

Visual Observation.—"In making a test run, the test car was brought up to speed before reaching the beginning of the test course. The hand throttle on the steering column was then locked in position. When records of wheel revolutions were desired, the space-time recorder was also started before the car reached the beginning of the test course. As the starting line was crossed, the driver started a stop watch and pressed a push button to indicate the beginning of the run. During the time of the test, one observer recorded the readings of the ammeter and voltmeter; the other recorded the gasoline gage readings and looked after the operation of the space-time recorder. Upon crossing the finish line, the driver pressed the push button to indicate the end of the run, stopped the watch, and released the throttle. The readings of the stop watch and those of the gasoline gage were then recorded, after which the car was made ready for the return run."

Photographic Records.—"Much the same procedure was used in recording the data by the photographic method. Its main advantages were that it enabled simultaneous reading of all the instruments and that the time between successive readings could be made very short. With the equipment used in these tests it was possible to take photographs at the rate of one exposure per 100 feet of road surface with the car traveling 40 miles per hour."

Changes in Tire Radius.—"An apparent discrepancy in the ratio between the rolling radius of the wheel and the radius of the drums was noted. When investigated it was found that the radius of the tire increased as the speed increased. An average increase in radius of about 0.75 inch was observed when the speed was increased from 5 to 65 miles per hour, equivalent road speed. This factor was carefully checked in road tests."

(To be Continued)

▼

Oiled Road Maintenance in Kansas

A carefully organized personnel maintains the oiled road mileage of Kansas. The following account of the organization that does this work is taken from a paper presented by Harold Allen, Material Engineer of the Kansas State Highway Department, at the National Road Oil Congress held last month at Tulsa, Okla.

First the state is divided into six divisions and each subdivided into four or five districts. Each division has a trained oil crew, 800 gal. distributor, necessary blade equipment, and from one to five 1½-ton trucks. This crew works over the whole division and their duties consist of major repair work, such as sealing long sections, scarifying and reconditioning mats, shoulder oiling and base repair when necessary. They are equipped to completely build any type of bituminous surface if necessary.

The district oil crew is essentially the same as the division oil crew with the exception of equipment. They have a 2-wheeled trailer distributor of 300 gal. capacity, a 1½-ton truck and small tools. Patching material is available at the section man's shed. The district oil crew's duties are minor repair jobs in their district, such as spot sealing, patching and repairing short sections. When the surface is in such condition that routine maintenance is all that is necessary the district oil crew is free for any other maintenance duties necessary.

The section-man and helper maintain approximately 30 miles of oil. They are equipped with a 1½-ton truck, light blade, small tools, roller, mower, snow fence and snow removal equipment. Patching material and small storage space for oil are provided. The daily maintenance duties of the section-man consist of patching small faults, rolling shoulders, cleaning right of ways, ditching and shouldering, resetting guide posts, guard rail posts and road signs. At present standard section-men's garages are being designed to be built in panels for removal to new locations as the need arises. In general these garages will be semi-permanent and will be near the center of each section. Each garage will have about one acre of ground, fenced in, with material and oil storage room.

▼

Four Foot Finishing Machine Used on Ohio Job

What is said to be the smallest finishing machine ever constructed was used on The S. Monroe & Son Co. job at Lexington, O.—Richland County. This work was on Ohio State Project No. 206, which was 18,480 line ft. long. Concrete was completed Nov. 8.

The 4 ft. flex-plane finishing machine was used to screed the concrete forward and backward. It also installed a poured transverse contraction joint every 30 ft. The track wheels on the one side of the machine ran on the steel road forms; on the other side flat face track wheels were used to run on the old concrete pavement in place. The machine eliminated the old method of striking off the concrete with a wooden strikeoff, which requires two men to operate.

The job was in charge of The S. Monroe & Son Co.'s Superintendent, Hayden Miller; the engineers were Mr. Robert Hancock and Mr. Stanley Horn.

UNEMPLOYMENT RELIEF, POLITICS, AND ENGINEERS

ENGINEERS, like other white collar workers, have been less aggressive in looking after their welfare than have other groups. Explanation of this fact and opinions as to what should be done will vary. One commentator whose opinion should be of value is Mr. Arthur Richards, Research Director, New Jersey Taxpayers' Association. We quote below from his paper on the effect of the depression on engineering compensation and employment, presented at the Congress of the American Society of Municipal Engineers and the International Association of Public Works Officials, held at Rochester, New York, September 24, 1934.

Relief Methods.—"Various plans and methods of relief have been adopted throughout the country in developing programs to assist the unemployed citizens of each community. Engineering clubs and societies in many cities have organized committees for the purpose of helping engineers to secure employment or relief, and the usual forms of assistance are:

1. Helping to secure more or less permanent engineering positions.
2. Money loans or gifts from funds contributed by engineers.
3. Employing engineers on relief work financed by funds contributed by engineers.
4. Helping to secure temporary positions on 'made-work' projects financed from local, state or Federal funds for relief purposes.

"The made-work projects of relief projects have covered many kinds of work, but up until this year they usually were of the type requiring general or common labor, as, highway, sewer, drainage and park construction and maintenance, and very little relief work was planned for other classes of workers.

"Quite a few of the unemployed engineers in the past three or more years secured temporary work on relief projects, but a survey of fifty large cities throughout the country indicated in 1933 that of the hundreds of millions of dollars which had been expended up to that time for labor on work relief projects, less than 4 per cent had been spent for labor performed by the so-called 'white-collar' unemployed.

"In other words, over 96 per cent of the relief funds used for labor on made-work projects had been expended for the benefit of what may be called the 'general labor' group, while the white-collar workers, among which are included the engineers, were unable to secure but a very small allocation of relief funds for the kind of work which they could perform.

"Generally speaking, the people of the United States are divided into three main groups, and the gainful workers 18 years old or over, reported by the 1930 census, may be distributed about as follows:

Group	Persons	Per cent
Agricultural	9,740,000	20.9
General labor	20,695,000	44.3
White-collar	16,249,000	34.8
	46,684,000	100.00

"The first two groups are partially organized for their social and economic welfare, while the third group is not. Particular attention is called to the above paragraphs as they are evidence of the failure of the engineering profession and other persons of the white-collar group to reasonably gauge the extent of the depression, and to provide equitably and adequately for the relief of their unemployed members through the means of public relief funds.

"Unquestionably the white-collar group will bear a great share of the burden in paying for the many billions of dollars which must be paid in the future for the relief and recovery measures of the present time, and while the group has suffered as much from unemployment and financial losses as any other group, it has received very little direct benefit to date from the billions of dollars which have been spent in an endeavor to break the depression and to provide work or relief for the unemployed.

Suggested Work for Engineers.—"A study of the present status of affairs shows the urgent necessity for further endeavor on the part of all engineering societies and all members of the profession to work and plan for a general recovery of business. The wave of retrenchment which has swept over the country in respect to the construction of public works has seriously affected the members of the engineering profession, and if the present condition continues much longer they will be reduced to such a low economic status that it will take years to make even a partial recovery.

"Many useful surveys and investigations which would require the services of engineers and other white-collar workers could be conducted in most every community, and the following list of projects includes some of the kinds of made-work which have been performed in various cities, counties and states:

Traffic Survey: Comprehensive survey in the city or county.
Boundary Survey: Survey of the city or county boundary lines.
Street Survey: Survey to monument all city streets.
Bench Mark Survey: Survey of bench marks in city or county.
Underground Survey: Survey of all public utility lines.
Sewer Survey: Investigation of sewerage systems.
City Block Maps: Prepare new or bring old maps up to date.
County Tax or Land Maps: Prepare new or bring old maps up to date.
Bridges and Culverts: Make survey of all existing structures.
Streams and Drainage: Surveys for encroachments and improvements.
Highway Pavements: Surveys to tabulate types and conditions.
City Planning: Investigate zoning and parking conditions.
New Projects: Preliminary surveys and investigations."

Politics and Relief.—"Prior to the advent of large sums of Federal Aid funds to assist on work relief

projects in the latter part of 1933, the selection of unemployed workers for such projects was usually based on sound social service procedure, and appointments mostly were made free from political influence or preference.

"With the advent of Federal Aid, the political spoils system began to assert a real influence in regard to work appointments, with the result that within a short time most all positions other than common labor were filled mainly by political preference.

"A typical illustration is shown by the appointments of the personnel for the real property inventory made in sixty cities spread throughout the country. This work could have been most successfully performed by the unemployed engineers, architects and draftsmen, but instead, the selection of the workers was given to the city or county political chairman in many instances and the appointments were made entirely by political preference.

"The writer has no desire to inject politics into this paper, but the record of recovery attempts and procedure should present the political facts for future guidance in depressions to follow.

"Without holding any brief for or against the party in power, as professional politicians of any and all parties play the same kinds and brands of pernicious politics, it is a severe indictment on our vaunted civilization that in a major calamity like the present depression the politicians are allowed to spend billions of dollars on various insecure theories of which many have a strong political significance.

"The amortization of the recovery debts will fall upon all kinds of people of every political belief, and it would seem that the politicians for once should have had enough common decency to forgo the evils of the spoils system and instead equitably plan relief and recovery measures for the benefit of any and all persons who have been affected grievously by the depression."

Conclusion.—"The history of the depression will be written best many years after it is over and when a non-political analysis can be made to ascertain the facts.

"However, without waiting for the last analysis, the past record of experience has clearly demonstrated that professional groups, such as engineers, were totally unprepared for the emergency. As previously mentioned, the white-collar group has received to date but a meager share of the many billions of dollars expended for relief purposes.

"That this is true, is because professional groups and the white-collar workers as a whole have never organized for their mutual welfare, and thus when a major economic depression occurred were not in position to properly plan and provide for their well-being.

"Their political force and influence are practically nil and the history of the past few years has clearly shown that politics thrives on a depression when billions of dollars are being spent for relief and other purposes.

"We, as professional engineers must recognize the facts of political aspects and social service as they exist, and must plan our own economic welfare accordingly. Not to do so, is unfair to those dependent upon us."

▼

Proposed Inter-American Highway Technically Feasible

A highway more than 3,200 miles long, connecting the southern boundary of the United States with the Panama Canal Zone and traversing Mexico and Central America, is pictured in engineering and economic terms in an official government report just issued under the title, "The Proposed Inter-American Highway."

The report, prepared by the Bureau of Public Roads, U. S. Department of Agriculture, and published as Senate Document No. 224, 73rd Congress, covers all phases of this important project, which is the first long highway definitely planned to pass through several independent countries.

The termini of the Inter-American highway are Nuevo Laredo in Mexico, just across the Rio Grande from Laredo, Texas, and Panama City, Republic of Panama. Between them, the completed road will stretch about 3,250 miles, amid the contrasts of thriving cities and tranquil native villages, of volcanic peaks and tropical jungles. While the report describes the highway as "proposed," it is in fact already well on the way to realization, for of its total length approximately 40 percent is now open to year-round traffic and an additional 27 percent is good or fair in dry weather. To establish connections between the sections of road already built and to modernize existing highway where necessary, is the task confronting the five Central American Republics, Panama, and Mexico.

The principal sections of the route now open are in Panama, where the motorist can cover with ease in dry weather the 340 miles between Panama City and Concepcion, only a few miles from the Costa Rican border; and in Honduras, El Salvador, and Guatemala, where in dry weather a continuous route is open to passenger cars, trucks, and busses. In Mexico, the last section of an all-weather road about 760 miles long between Nuevo Laredo and Mexico City is now being completed.

The Bureau of Public Roads report is based upon a careful reconnaissance survey in Central America, during which the American engineers, with the assistance of officials of the countries traversed, covered hundreds of miles of territory. Extensive aerial photography helped the engineers select the most practicable route. That a through highway between the United States and Panama is "entirely feasible from an engineering point of view," is the conclusion of the engineers.

Estimates of cost to complete the road through Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama are made on three types of construction: (1) 18-foot surface of local materials, approximately $30,000,000; (2) same surface, but with oil treatment, $38,000,000; (3) 20-foot cement concrete surface, $101,000,000. The completion of the Mexican section to the Guatemala border would add 80 percent, 67 percent, and 58 percent, respectively, to these estimates, assuming the sections already improved in Mexico would be used without change in type.

The proposed route will touch every capital from Mexico City to Panama save one—Tegucigalpa, Honduros—which will be reached by a spur line. Of the estimated 6,000,000 population of the Central American Republics and Panama, 54 percent is in provinces traversed by the route and 28 percent in contiguous provinces. The line follows roughly the Continental Divide at elevations usually ranging from 1,500 to 4,000 feet.

The report asserts that this highway "would probably do more to create cordial relations and brisk exchange, not only between the peoples of Central America and Mexico and the United States, but also among the Central American and Mexican inhabitants themselves, than all the diplomacy and 'good will' visits that could ever be devised."

Completed Pavement

PAVEMENT MAINTENANCE
Methods and Costs at Ann Arbor, Mich.

By GEO. H. SANDENBURGH
City Engineer, Ann Arbor, Mich.

ANN ARBOR'S first pavement, vitrified brick on a natural cement base, was built in 1898 on our main business street and this pavement is still in use and in first class condition after 36 years of service. Another pavement of this same type was built in 1899; this pavement is still in excellent condition. During the period 1900 to 1903, four streets were paved with asphalt block and one with brick, all laid directly on the subgrade. With the exception of four blocks of the asphalt block, these pavements are still in excellent condition. The total yardage of these pavements is 36,435 of which 7,187 yd. were rebuilt, leaving 29,248 yd. of the original pavement still in use. In 1907, one Warren Brothers bitulithic pavement was built which is now in good condition, though the wearing surface is getting thin.

During the period of 1909 to 1914, the city built 138,124 sq. yd. of what was known as Ann Arbor Tar-Concrete pavement. The cost of construction of these pavements over the period average 80 ct. per square yard for pavement only. These pavements are all in service today and are in excellent condition, considering the fact that bank run gravel was used and that the aggregate was mixed in a continuous mixer. The youngest of these pavements is 20 years old this year and the oldest 27 years.

Bituminous Resurfacing of Old Pavement.—From 1916 to 1921 some of these pavements became so rough that they had to be smoothed up in some way. We decided upon bituminous resurfacing. The following method was used on brick streets.

The surface of the street was covered with ⅓ gal. of Tarvia "A" per square yard, the tar was then covered with ¾ in. slag and then rolled with a 10-ton roller. Low spots were raised by adding additional slag and a second application of ¼ gal. of Tarvia "A" applied and covered with pea pebbles and rolled again and the street opened to traffic. Seal coats of Tarvia have been applied twice since. The street is now in good condition and has every appearance of lasting many years with very little maintenance.

Surface Treatment With Tar.—Surface treatment with tar has been the method of maintenance of the asphalt block and concrete pavements mentioned in the preceding paragraphs. As early as 1916, the pavements started to go to pieces and it was evident that extensive rebuilding would be necessary if some method of effective maintenance was not found. This method of bituminous surface treatment has proven so successful that we have been using it for the past 18 years.

For the first few years the tar was covered with a coarse sand. This covering was not entirely satisfactory as there was considerable picking up under traffic and it was practically impossible to keep traffic off the street long enough for the surface to dry out enough so that it would not pick up. We are now using a crushed aggregate and pea pebbles with the following sieve analysis:

CRUSHED AGGREGATE

	Per Cent
Passing ½ in.	100
Passing ⅜ in.	94
Passing ¼ in.	27
Passing No. 8.	2

PEA PEBBLES

Passing ½ in.	100
Passing ⅜ in.	80
Passing ¼ in.	25
Retained No. 8.	100

By using the crushed rock or pea pebbles of the above grading we have no trouble whatever with picking up. The street is opened to traffic as soon as the tar is covered. About six weeks ago, we surface treated a 11,000 sq. yd. in five hours with twelve laborers, six trucks and drivers, one distributor with driver and operator and one roller and operator. Tar was hauled an average of two miles and cover material 2½ miles. Cover material cost $1.90 per ton f.o.b. cars, tar $0.094 per gal-

lon f.o.b. cars. Cover material was loaded into trucks by means of a power clam-shell bucket.

I could make my talk very short by saying that we have maintained these pavements by spreading tar on the surface and covering the tar with pea pebbles or crushed rock. That is the whole story. However, to be more specific, I will explain our method in detail.

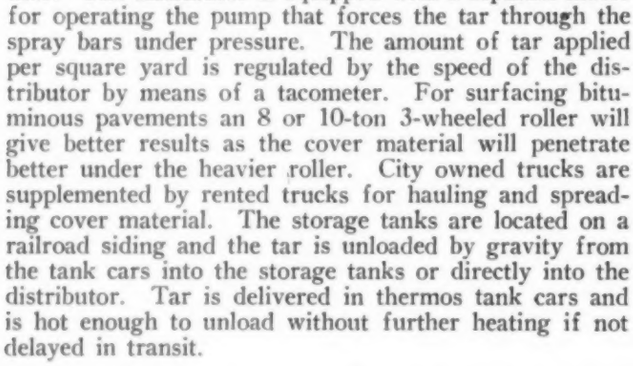
Cover Material: For cover material pea pebbles or crushed rock (100 per cent crushed gravel) of the following sieve analysis, is used:

	Per Cent
Passing ½ in.	100
Passing ⅜	80 to 95
Passing ¼ in.	20 to 30
Passing No. 8	5 to 10

Material Costs: Pea pebbles are purchased from a local gravel company and cost $1.10 per cubic yard at their plant two and one-half miles from the center of the city. Crushed rock is shipped in and costs $1.90 per ton f.o.b. cars. Tar this year cost 9.4 ct per gallon, f.o.b. cars and has averaged 10 ct. per gallon over a period of ten years. I believe that better results will be obtained by using crushed material. This is the first year that we have used crushed material. There is very little difference in the appearance of the surface and the only advantage in using crushed material is that better adhesion is obtained due to the rough surface.

Equipment.—Our equipment consists of one Municipal Supply Co. 1,000 gal. capacity motor distributor, equipped with a heating device capable of heating tar to 300° F. One 5-ton, 3-wheeled roller; four 2 yd. trucks; two 12,000 gal. storage tanks, equipped with heating coils; heating boiler and a motor driven pump for pumping tar from the storage tanks to the distributor. The distributor is equipped with a separate motor for operating the pump that forces the tar through the spray bars under pressure. The amount of tar applied per square yard is regulated by the speed of the distributor by means of a tacometer. For surfacing bituminous pavements an 8 or 10-ton 3-wheeled roller will give better results as the cover material will penetrate better under the heavier roller. City owned trucks are supplemented by rented trucks for hauling and spreading cover material. The storage tanks are located on a railroad siding and the tar is unloaded by gravity from the tank cars into the storage tanks or directly into the distributor. Tar is delivered in thermos tank cars and is hot enough to unload without further heating if not delayed in transit.

Methods of Construction.—The surface of the pavement to be treated must be thoroughly clean. It should be swept and then flushed. The hot tar is then applied in an amount averaging 0.3 gal. per square yard. Application of cover material follows immediately and is applied by dump trucks backing up onto the tar with the end gate opened enough to apply a slight excess of cover material. From 16 to 20 lb. of cover material per square yard are used. We find it better practice to have too little cover material than to apply too much. If bleeding occurs, additional material is easily added. If too much material is applied it is whipped into the gutters and causes a waste of tar. Although the cover material is spread from trucks backing onto the tar, this spreading is supplemented by hand labor to secure even distribution. From our experience this year, we find that crushed material spreads as well as the pea pebbles. As soon as the cover material is applied the roller starts and the three operations of spreading tar, spreading cover material and rolling are carried on simultaneously. We have plenty of trucks hauling and spreading cover material so that the application of this material follows the tar distributor closely and the entire surface of the street is covered with cover material very soon after the tar is applied. The street is then opened to traffic and rolling continues until the entire surface has been rolled.



Spreading Material

We find that it is not necessary to close the street to traffic during this work if drivers are careful and do not drive on the tar before it is covered as the work proceeds from one side of the street to the other and one-half of the street can be used while the other half is being surfaced.

We have very little trouble with the tar getting on cars. There is not much picking up the day of application and none after the first day. I have not had a complaint of a car being spattered with tar in over two years.

One surface treatment as described will last from four to six years depending on the amount of traffic on the street. We experience very little peeling and where peeling occurs the bare spots are patched. Care is now taken to not build up too thick a mat as shoving occurs when too thick a mat is obtained. When bare spots appear on a pavement, instead of surfacing the entire area as formerly, we now patch the bare spots only. We have surfaced several street railway tracks and the treatment sticks to the rails.

Cost of Surface Treatment.—The cost of the surface treatment, as described, necessarily depends on the cost of material, truck hire and equipment rental. Our costs over a period of years have averaged 6 ct. per square yard. The last few years, it has been 5.8 ct. due to cheaper tar and better equipment. Until 1930 a horse-drawn distributor was used. Our motor distributor has nearly twice the capacity and trips from the storage tanks to the street care are made in one-sixth the time it took with a team. Consequently, production increased and costs decreased.

Our costs per square yard for an 11,000 yd. job constructed in August of this year are as follows:

	Per Sq. Yd.
Tar	$0.0282
Cover material	0.0140
Labor	0.0051
Equipment	0.0077
Heating and miscellaneous	0.0020
Engineering and supervision	0.0010
Total	$0.0580

Costs based on 100,000 sq. yd. constructed in 1933 are as follows:

	Per Sq. Yd.
Tar	$0.032
Cover material	0.006
Labor	0.015
Equipment rental	0.004
Heating and miscellaneous	0.002
Engineering and supervision	0.001
Total	$0.060

Life of Treatment.—Our experience shows that each surface treatment has a life of from four to six years, under previous practice. Under present practice of patching bare spots, complete resurfacing can be delayed for longer periods of time.

This type of treatment is just as successful if not more so when used on asphaltic concrete and sheet asphalt pavements. Pavements of this type that have cracked excessively can be made to look like new pavements by this surface treatment and in addition a non-skid surface is produced. Tar seems to soften the asphalt, renew its life and prevent further cracking. We are now experimenting with a kerosene cut-back asphalt, on a small scale, for resurfacing sheet asphalt and asphaltic pavements. I presume regular cut-backs or emulsions would give good results, but we have had such good success with tar that we are reluctant to change until we are convinced something else is better.

This work should be done during hot weather so that bleeding occurs enough to completely coat the cover material. This resurfacing waterproofs the surface of the old pavement and provides a new surface to take the wear. These two points are the secret of its success.

From our experience during the past 18 years, I see no reason why pavements cannot be maintained indefinitely by the methods described.

Low Cost Bituminous Pavements.—The Board of Public Works built an experimental low cost pavement in 1927. The street selected for this experiment is ½ mile in length and 34 ft. wide. The surface was gravel on a sand sub-grade; the street is curbed and guttered.

The dust and loose material were swept off the surface with a tractor driven rotary broom. One-third of a gallon of Tarvia "B" per square yard was then applied to the surface and allowed to penetrate for 24 hours when another application of ¼ to ⅓ gal. Tarvia "B" was applied and covered with pea pebbles and the street opened to traffic and the surface dragged with a brush drag. The following summer a seal coat was applied and another seal coat in 1930. There has been no further maintenance to date and the street is in good condition. The cost of this surfacing was 18 ct. per square yard including the second year's seal coat.

Due to the success of this experiment, we started a large program of low cost bituminous pavement construction in 1931 which we call bituminous dust layer. Yardage built during the last four years is as follows:

	Sq. Yd.
1931	151,000
1932	180,260
1933	78,747
1934	20,778
Total yardage built	431,785

The above yardage comprises some 23 miles and is spread over 110 different districts. The work is done on a petition assessment basis, the property owners paying 80 per cent of the cost and the city 20 per cent. The city pays 100 per cent of cost of intersections. Fifty per cent of our streets are paved with high class pavements and 32 per cent are paved with low cost bituminous pavements. These low cost pavements are very popular with our citizens, and we now have about 20 petitions on file, which we are unable to take care of due to lack of finances for the city's share. The property owners' payments are spread over a period of three years.

Applying Covering

Method of Construction.—An inch to an inch and a half of gravel passing an inch screen and retained on a ¼ in. screen is added to the street to be paved. The surface of the street is then scarified about an inch to provide fines. The surface is then smoothed out and ½ gal. of tar per square yard applied hot. The tar and loose material are then mixed with power graders until the material is uniformly black. The mixed material is then leveled across the street and another application of ¼ to ⅓ gal. of tar applied and mixed again until uniform in color, leveled off and the street opened to traffic for two to three weeks when a seal coat is applied. A second seal coat is applied the next year. The total thickness of wearing surface is about 2 in. The pavement is then good for from four to ten years' wear with ordinary maintenance according to our experience of the last four years with 151,000 sq. yd. and eight years' experience with 9,000 sq. yd.

In 1931 we did not add extra stone but just used the material on the street and scarified it to a depth of 1½ in. During 1931, we built both surface treatment and road-mix jobs. The road-mix jobs were the heaviest traveled streets. After costs were compiled we found that the road-mix method did not cost any more than the surface treatment, so we have used the road-mix method since. The cost of picking up the dust and loose material swept to the gutters in the surface treatment method was as much as the cost of mixing in the road-mix method.

Costs.—The cost per square yard for jobs built in 1931 was 12.7 ct. without the second year's seal coat and 19 ct. with the second year's seal coat. This compares very well with our seal coat experience on pavements in the last 18 years which ran uniformly about 6 ct. per square yard.

When we found these low cost pavements could be built so cheaply, we thought we would make them better by adding new stone to make a better and more stable wearing surface. The addition of this new material in-

creased the cost from 19 to between 25 and 26 ct. per square yard as follows:

	Per Sq. Yd.
Tar	$0.1111
New stone	.0232
Pea pebbles for seal coat	.0060
Labor	.0277
Equipment	.0776
Heating and miscellaneous	.0057
Engineering and supervision	.0057
Total per square yard (1st year work)	$0.1970
Second year seal coat	0.600
Total	$0.2570

For the road-mix part of our low cost bituminous pavements we use what is known as a heavy retread tar meeting Michigan State Highway Specification TM. For the seal coat we use Tarvia "A" or tar meeting Michigan State Highway Specification TH. The road mixing is done by Austin 77 motor graders, one single and one double drive. The dual drive is much better for this work.

We aim to get a mixture of from 1½ to 2 in. in thickness. When the thickness gets much over 2 in., shoving occurs. It is better to have the mixture a trifle dry than too fat as the seal coat keeps the surface from raveling.

Quantities.—Amount of tar used per square yard in these low cost pavements is as follows:

	Gal.
First road-mix application	.50
Second road-mix application	.33
First year's seal coat	.30
Second year's seal coat	.30
Total per square yard	1.43

For seal coats, we use ¼ gal. of tar per square yard and from 16 to 20 lb. of cover material to the square yard. Although we have used tar almost exclusively in our work we used one tank car of cut-back asphalt in 1933 for seal coat work and to date it is entirely satisfactory.

These low cost pavements have proven successful on all but a portion of one street for about 100 ft., which has a clay subgrade and did not have a sufficient depth of gravel on top of the clay and was not properly drained before the pavement was laid.

This type of low cost pavement (which we call bituminous dust layer) costs very little more than the cost of an annual dust layer. It further provides you with a dry street surface during the fall, winter and spring and a dustless surface during dry weather. When the property owners' payments are spread over a period of three years, it costs him no more each year than an annual dust layer. Whatever the life of these pavements is over three years, it saves the property owner each year the yearly cost of an annual dust layer. Furthermore. this work has reduced our cost of maintaining gravel streets from $30,000 to $5,000 per year. Our streets are in much better condition and our residents are satisfied.

The foregoing is a paper presented at the recent annual convention of the American Society of Municipal Engineers.

▼

PERU HAS 11,703 MILES OF HIGHWAYS—The preliminary figures of the Office of the Director of Public Works and Transportation, on June 30, 1934, showed the total highway mileage of Peru as 11,703 miles, divided by types of construction as follows: Unimproved earth, 2,497 miles; improved earth, 3,227 miles; crushed stone, 4,781 miles; water-bound macadam, 1,119 miles; cement and reinforced concrete, 80 miles; and asphaltic concrete, 9 miles.

Tire Radius Increases With Speed of Car

Studies on tractive resistances as related to roadway surfaces and motor vehicle operation conducted by the Iowa Engineering Experiment Station, and reported by R. G. Paustian in a bulletin (No. 119) dated August 1, 1934, brought out the interesting point that tire radius changes with car speed.

The report of road tests relating to tire radius is as follows:

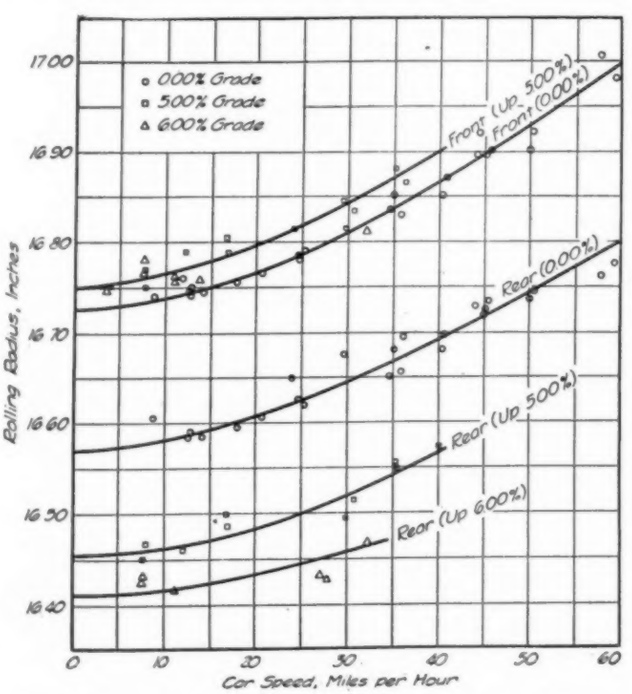
"In the discussion of the results of the laboratory calibration, it was indicated that a change in the rolling radius of the tires accompanied a variation in speed. A number of road tests confirm this observation and offer proof that the higher the speed the greater the rolling radius of the tires.

"The tests upon which these results are based were made by counting the revolutions each wheel made while the car was driven over a measured course.

"Both the front and rear tires at high vehicle speeds made fewer revolutions than at 0 to 5 miles an hour, but at high speeds the rear tires made more revolutions per mile than did the front wheels, indicating that the rolling radius of the front tires increased more than that of the rear tires.* Values taken from tests on a level road indicate an increase of 0.20 inch in the rolling radius of the front tires of the test car as compared to 0.17 inch for the rear tires when the speed was increased from 0 to 50 miles per hour.

"It is natural to expect, as the results show, that the rolling radius of the front tires of a car going up a grade would be greater than that of the rear tires. Values from tests on 0-, 5-, and 6-per cent grades are given in the figure and indicate how the rolling radius is affected by both speed and grades. On the ascending grades the smaller rolling radius of the rear wheels is due mainly to the added power required to drive the car up the grade."

*Query by Editor: May the greater number of rear tire revolutions not be due to slippage under driving force?



Effect of Speed and Grade on the Rolling Radius of Front and Rear Tires

EDITORIALS

Greda Crossing Removal As a Worthy Use of PWA Funds

IN 1933 there were 1,511 people killed and 3,697 injured at highway crossings over railway tracks. There are about 240,000 grade crossings; and since it costs about $40,000 to replace the average grade crossing with a crossing below grade, nearly 10 billion dollars would be required to eliminate them all. But by selecting only those where highway traffic is dense, probably an expenditure of one billion dollars would cut in two the number of fatal accidents.

A plan to spend about $250,000,000 of PWA money in 1935 is said to have met the approval of Relief Administrator Hopkins, Transportation Coordinator Eastman and Secretary Ickes. This plan was suggested by President Ralph Budd of the Burlington Lines. Mr. Budd estimates that about 12,000 grade crossings are so dangerous as to call for immediate removal. He estimates that about 90 per cent of the cost of their removal would be paid out to workmen, whereas Mr. Eastman estimates 35 per cent. Evidently this disagreement arises from the fact that Mr. Eastman was thinking of the field labor only, whereas Mr. Budd had in mind also the labor expended in producing and transporting the materials and equipment used in building the new crossings. Mr. Budd's point of view is entirely sound, for of all the large classes of workmen most in need of employment, no class is more desperately needy than the men who make cement, crushed rock, steel and other materials used in building subtrack crossings.

It will be difficult to select any class of public works more worthy of large expenditures of money than the one in question; for at the same time that much needed work is provided for the classes having the greatest percentage of idleness, there will also be effected a saving of hundreds of lives annually.

▼

Laws to Prevent Diversion of Highway Funds

IN THE November elections the voters of Colorado supported a constitutional amendment that prohibits the diversion of gasoline taxes and motor license fees. They defeated an amendment to reduce the gasoline tax from 4 to 3 cts. per gallon. In Ohio a similar amendment to reduce the gasoline tax was defeated, but they also defeated an amendment to prevent diversion of any of the tax. In Michigan an amendment to reduce the gasoline tax was likewise defeated.

These three defeats of attempts to reduce the gasoline tax indicate that even in these hard times the voters are willing to be taxed heavily for road improvement. Unfortunately only Colorado voted against diversion of gasoline taxes. In Ohio the schools receive 1 ct. of the 4 cts. collected from gasoline taxes. Since no provision was made for some other form of tax to take the place of this 1 ct. per gallon for school purposes, the voters evidently were against reducing the school funds. They might have supported a general sales tax for school purposes, and some such alternative should have been presented to them. The best way to overcome the diversion of gasoline taxes is by means of a general sales tax.

In our November issue a detailed statement was given showing that in 1932 about $1,000,000,000 was collected in the United States from fees and taxes relating to motor vehicles. About 7 per cent of this total sum was diverted to general funds, unemployment relief and schools. The diversion was probably not much less than 20 per cent in 1933. Hence the urgent need of laws to stop the diversion of these "highway tolls."

The most serious aspects of this diversion problem arise from two causes: first, the urgent need of money for relief of unemployment; and, second, the demands of school teachers that their salaries be not reduced. Diversion of road funds does not help the unemployment situation, for the diversion throws highway workers out of jobs and into the relief ranks. As for the school teachers whose salaries have not been decreased, the fact is that they enjoy an increase in "real wages" of fully 25 per cent because of the decline in the cost of living since 1929. They can therefore stand a decrease of 25 per cent in "money wages" without suffering any decrease in "real wages." We are not advocating any such decrease in their "money wages," but are pointing out the unfairness of their propaganda calling for diversion of gasoline taxes, etc., to school uses. They have completely lost sight of the fact that such diversions throw out of jobs men who are sorely in need of employment.

▼

Code Matters of Interest to Contractors

WHEN a contractor is considering the submission of a bid on a pending job, one of the more important problems he faces is the determination of the code or codes under which the work must be performed. At present (Nov. 15, 1934) highway contractors are operating under the General Contractors Industry Code (Code No. 244, Supplement No. 1). A code for the highway construction industry is pending.

Does compliance with the General Contractors Industry Code, the Highway Construction Industry Code when it is approved, constitute complete code compliance? The answer is that it does not. Codes may be described as functional in their operation and as the work of a highway contractor may involve several functions the work he is to do may be, and indeed often is, subject to several codes though all of it is done on one job.

As an illustration, in the erection of a large draw bridge, though the major part of the work is subject to the General Contractors Industry Code, the steel work may be handled under the Structural Steel and Iron Fabricating Industries Code (Code No. 480) and the electrical work, if any is required in connection with the draw span, will fall under the Electrical Contracting Industry Code (Code No. 244, Supplement No. 6). Should the contractor attempt to produce sand, gravel or broken stone for any part of this work (except when the structure is publicly owned and the material he produces also is publicly owned or controlled), he must also reckon

with Code No. 109, the code for the Crushed Stone, Sand and Gravel and Slag Industry.

This is but an illustrative manner of presenting the fact that in the construction field code compliance may not be fully attained by compliance with the code under which the contractor is working and to which he has given assent. There are a considerable number of codes which may affect the performance of parts of his work and when any of these apply, full code compliance is had only when the provisions of these codes as well as the code under which he is working, are fully observed. A great deal of trouble both contractors and awarding officers now have with charges of non-compliance would be avoided if contractors would familiarize themselves with the scope of codes other than the General Contractors' Code, with the matter of their applicability on pending jobs and with such of their provisions as may affect the validity of bids on jobs on which such codes apply.

Inquiries concerning the scope of codes, their applicability on specific work, and the effect of any of their provisions on bidding practices should be made of the code authorities for the region in which pending work is located.

▼

How Old Is An Engineer?

POPULAR opinion holds civil engineering as preeminently a profession of youth; but in that idea, as in so many others, is more wrong than right. Phases of engineering, to be sure, belong to the young: twenty-five will excel fifty in setting up on a ticklish bit of rock or chaining all day through swamps; but twenty-five will be far behind in determining the economic justification of the line.

Engineers, of course, have a general understanding of these relations, but few have any definite figures on the subject, and for that reason especial interest attaches to a recent study of the ages of chief engineers by Arthur Richards, included in a paper on the compensation and employment of engineers before the National Congress of the American Society of Municipal Engineers and the International Association of Public Works Officials.

While it can hardly be said on the basis of Mr. Richards' figures, that "life begins at forty," it is evident that a good part of it is at its best after forty. The best salary period, for example, is the 26 years from forty to sixty-six; while the age of peak salaries appears to be sixty. Also, in the year 1930, about 77 percent of the chief engineers were more than forty years old—a substantial advance from the average for the 20 years preceding, when only 60 percent exceeded forty.

Mr. Richards presented no statistics for the grades below chief, but did comment that according to the 1930 census, more than 40 percent of all professional engineers were over forty years old—not a bad showing for the old man when you stop to think of it.

Mr. Richards' curves and accompanying text follow.

"It has been claimed many times that after men reach the age of forty their services are not in great demand. The loss of positions during the past five years by many persons over the age of forty has caused them great concern in reference to future employment. In regard to the profession of engineering it readily can be proved that at the age of forty the engineer is really starting out on the most interesting and active period of his professional career.

"Data compiled from the 1930 census shows that of the 35,021,770 males over twenty years old, 47.5 percent were over forty years of age, and that of the 226,000 professional engineers 40.2 percent were over forty years old.

"Chart O gives data on 12,322 positions of Chief Engineer between 1911 and 1930, and on 1,085 such positions in the year 1930. Curves C and D indicate the number of positions held at various ages, and show that between 1911 and 1930 the greatest number of Chief Engineers were age 40, and that in 1930 the largest number were age 44. The relative positions of Curves A and B indicate that during the twenty year period the relative age of Chief Engineers has increased. Curve A shows that 42 percent were 44 or more years old while Curve B shows that 58 percent were that age.

"Salary statistics in relation to age indicate that an age 66-year salary curve for Chief Engineers may be taken as equivalent to a 38-year salary curve, and this would mean that 26 years after the Chief Engineers reached the age of 40 they received higher compensation than they had received when they were 38. The peak salary year appears to be at age 60. The chart and salary statistics certainly do not indicate that the engineer has finished his active career when only forty years of age."

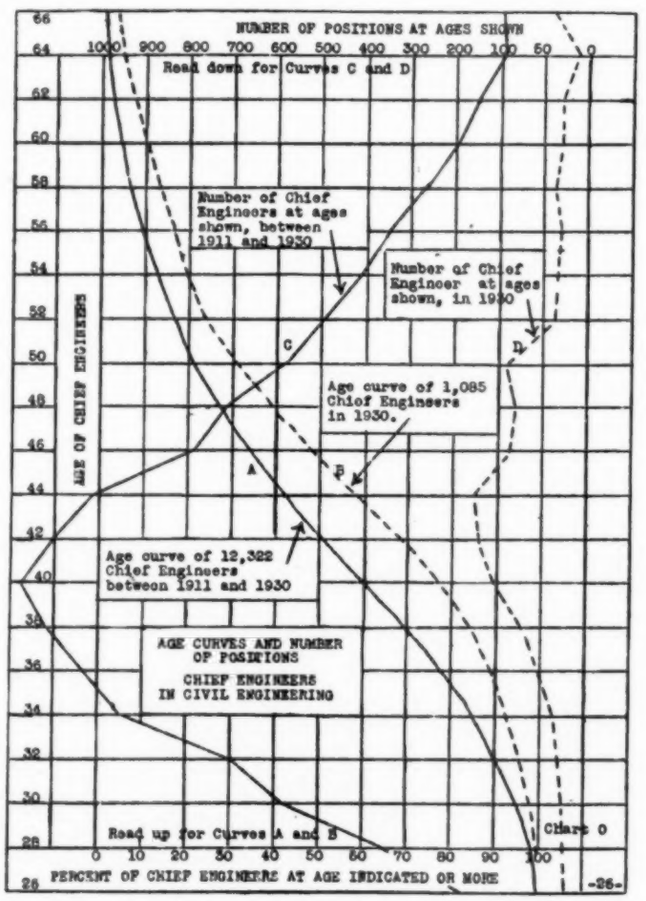
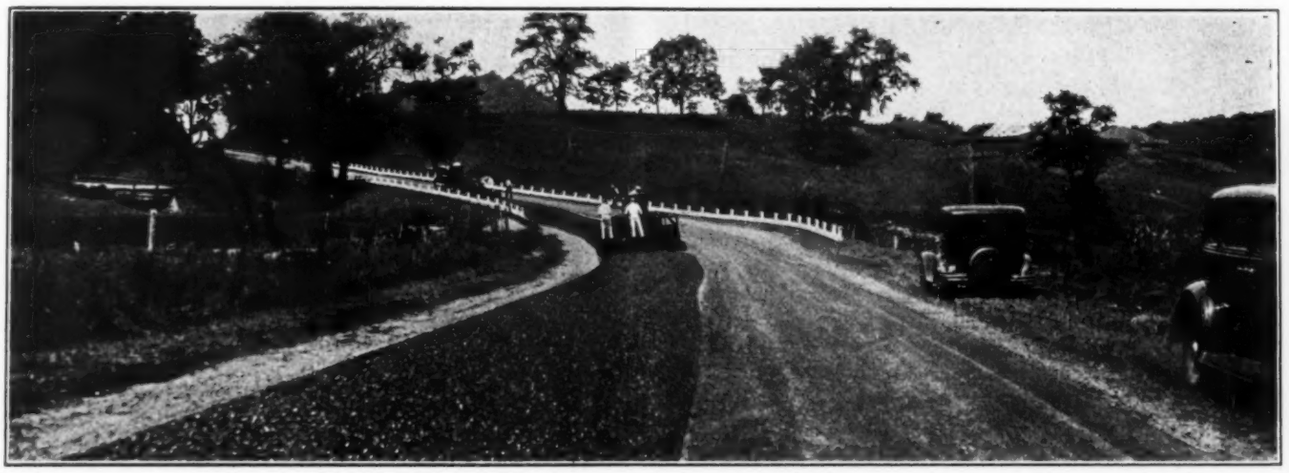

NUMBER OF POSITIONS AT AGES SHOWN
1000 900 800 700 600 500 400 300 200 100 50 0
Read down for Curves C and D
Number of Chief Engineers at ages shown, between 1911 and 1930
Number of Chief Engineer at ages shown, in 1930
Age curve of 1,085 Chief Engineers in 1930.
Age curve of 12,322 Chief Engineers between 1911 and 1930
AGE CURVES AND NUMBER OF POSITIONS
CHIEF ENGINEERS IN CIVIL ENGINEERING
AGE OF CHIEF ENGINEERS
66 64 62 60 58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26
Read up for Curves A and B
0 10 20 30 40 50 60 70 80 90 100
PERCENT OF CHIEF ENGINEERS AT AGE INDICATED OR MORE
Chart O
-26-

Chart Showing Number and Percentages of Chief Engineers at Various Ages

COUNTY AND TOWNSHIP ROADS

A Section Devoted to Those Interested In Secondary Road Improvement



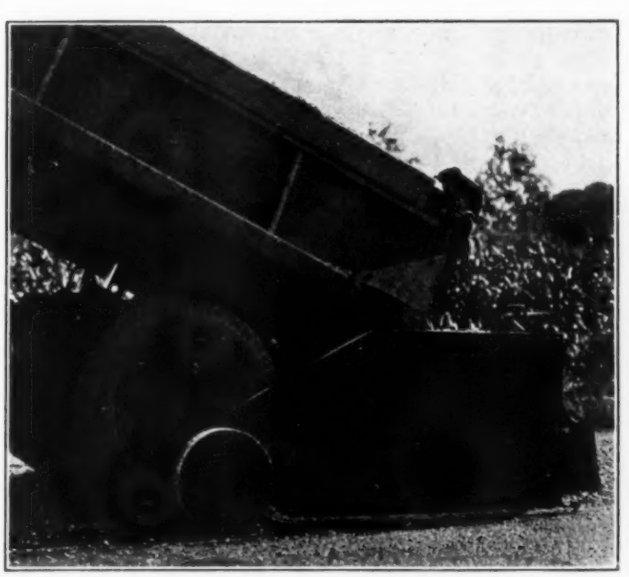
The Right Side of Road Has Been Mixed and Rolled the Previous Day, the Other Side as Left After the Road-Mix Machine Has Passed

RAPID RESURFACING WITH BITUMINOUS ROAD MIX

By G. M. ANDERSON
Division Engineer, Ohio Department of Highways

THE stage construction method of highway improvement is soundly established in American highway practice. The stabilization of graded and drained roadbeds utilizing reasonably priced local materials, such as gravel, crushed stone, slag, etc., has been the practice of the State of Ohio for a number of years, and at the present time there are on the system as a whole some 4,500 miles of such types of surface in various stages of improvement. It is recognized that the grading and drainage of such roadbeds should be of the same high quality as for the most expensive type of surfacing, and such procedure is fundamental to success.

After such surfaces had become stabilized through the addition of any needed additional aggregates under a traffic-bound method, they were next made waterproof by bituminous surface treatments. These treatments have been maintained over a period of years, so that there are now many miles having high support value and able to carry very substantial traffic. Some of the early work, however, was accomplished with higher crowns than are now deemed satisfactory for fast traffic and in other cases slight settlement had occurred under the very rapid increase of trucks and buses, especially on



The New Type Stone Spreader

The Stone for Road-Mix Is Spread on One Half Width of Road at a Uniform Rate Per Square Yard

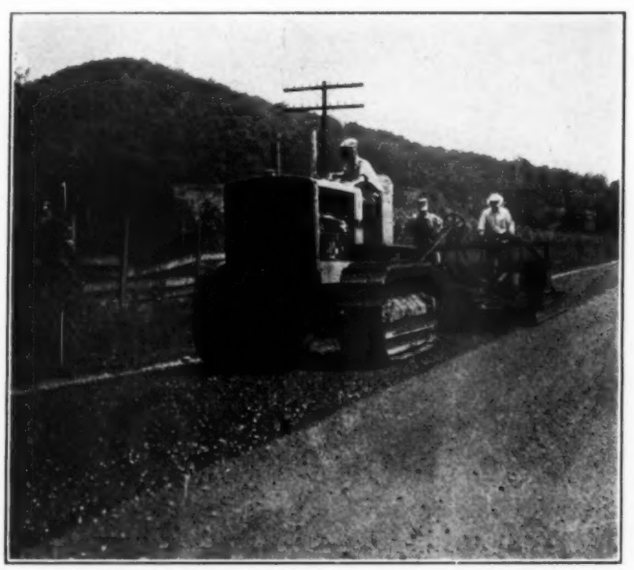
some of the main routes. So far as their structural strength is concerned very few of these roads require much additional thickness, but it is highly desirable to make the final step in stage construction by achieving the perfect smoothness that is so easily possible. In many cases this has been done by the construction of a road-mix top of approximately 2 in. depth and manipulated so as to eliminate the excess crown, and also to fill the small depressions. A further development is the use of the method for depths of lesser amount, even as small as ¾ in. average.

The earliest road-mix work was accomplished with bituminous material of fairly low viscosity in order to provide the necessary time for manipulation and the complete coating of the aggregate. This period was often as much as three or four days to a week, depending upon the weather. It was necessary to apply the aggregate to the surface, then apply the bituminous material in several applications, followed by blading and grading until a complete mix had been obtained. This necessitated either a detour to take traffic around the work, or else a disagreeable period to traffic if carried over the construction work.

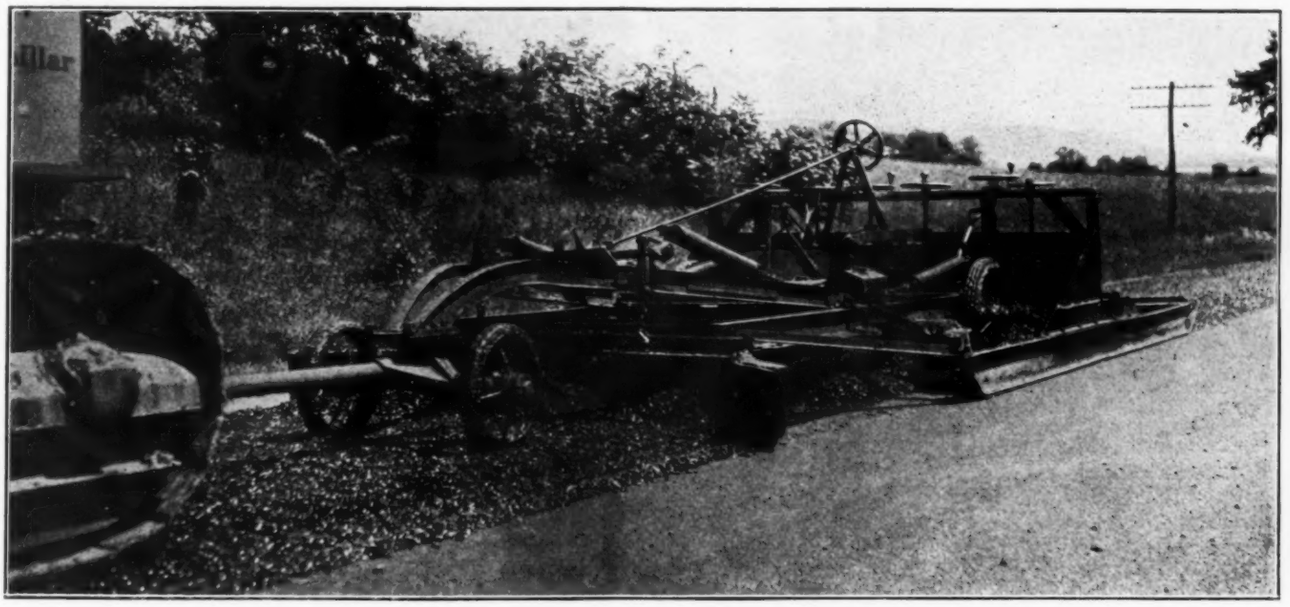
New Development in Road-Mix-Work.—Realizing the merit of the finished surface and at the same time appreciating that more and more consideration is owed by state authorities to the travelling public, the Ohio Department of Highways has made a new development in the technique of doing this class of work which both reduces the cost of the work itself and at the same time almost entirely eliminates inconvenience to traffic. Two distinct departures from older practice have been made: one—placing of the mineral aggregate upon the road only in the amount that can be completely mixed, spread and rolled in one day; the other—development of a new piece of equipment which accomplishes the mixing so efficiently and so rapidly that mixing and spreading are completed in one passage of the machine with rolling very shortly thereafter, and the road ready for traffic. The method of doing this work has been improved to the point where a considerable mileage can be accomplished in one day's time, and a brief description of one of the 1934 jobs may be of interest.

Road-Mix-Work on U. S. 50—The particular project is located on Route U. S. 50 east of Chillicothe, and as this is one of the main routes east and west, any detouring is exceedingly inconvenient as well as throwing traffic on local roads which may not have been designed to carry such concentrations. The length of the project was 6.8 miles, width of surface 20 ft., the old road being a traffic-bound gravel which had become thoroughly stabilized over the years, and thereafter surface treated. Mobilization of the necessary hauling equipment was made so as to bring in the crushed limestone gravel directly from the pit supply, an average haul of 7 miles. To provide the necessary thickness to insure a good seal coat and at the same time fill the slight depressions so as to make a perfectly smooth surface, approximately 50 lbs. of aggregate were required, a total of 293 tons per mile of 20 ft. width. The aggregate size was ¾-in. by ⅜-in. It was decided to do the work one-half width at a time and to carry traffic on the other half. The bituminous material used was a cut-back asphalt which was selected because of its rapid-curing qualities, and this phase of the work was handled with two distributors of 800 and 1000 gals. capacity. The average haul for the asphalt was 5.25 miles.

Aggregate Spread With New Type Spreader—A light application of cut-back asphalt (approximately 0.10 gal. per square yard) was made to the old surface as a tack coat and immediately followed by a light application of aggregate made by spreading through the tail gate of the truck so as not to inconvenience traffic. Following this tack coat and light cover, the full amount of remaining required aggregate was uniformly spread through a new type of aggregate spreader built in the Division Garage especially for this work. This spreader consists of a three sided box, with an apron to direct the aggregate from the end gate of a truck to the back side of the box, to which is mounted an adjustable strike-off blade. The two sides of the spreader ride on short runners to the front ends of which are attached two wheels, adjusted so that the wheels carry the load of the front end of the spreader, the front ends of the runners clearing the surface by about ½ in. The rear ends of the runners slide along the surface. The wheels are attached to cut down the friction and to prevent "digging in" of the runners. The runners are made short to prevent any appreciable spanning of profile irregularities so as to insure as nearly as possible the spreading of the same depth of aggregate on each square unit of surface. This insures uniform application of the bituminous material with respect to depth of aggregate, which in turn



After the Application of the Cutback Asphalt the Stone and Binder Are Mixed Together by a Multiple Blade Mixer Hauled by Tractor



Close Up View of Road-Mix Machine Showing 21 Ft. Long Channel Which Supports the Strike Off Screed

provides for uniformity of mix and uniformity of texture in the finished surface.

Closely following the stone application came the distributor, applying the full amount of cut-back asphalt required for the mix, approximately 0.50 gals. per square yard. Then following the distributor came a Baker multiple blade maintainer hauled by a Fifty Caterpillar tractor which gave the initial mix. Immediately behind this equipment came the new mixing equipment (designed in the State division garage) also hauled by a Fifty tractor. These two units were sufficient to thoroughly mix the aggregate and asphalt in one passage. If a greater depth of stone had been spread, possibly a heavier mixing unit might have been required to provide the preliminary mixing as the new equipment is capable of the final mixing and spreading for any depth to at least 3 ins. without additional power. In case the two units are not sufficient to provide for thorough mixing, a third mixing unit could be inserted in the operation.

The New Mixing Equipment—The essential features of the new equipment may be described as follows: In general terms it is a combination of two cooperating equipment units, one of which is a mixing and distributing unit while the other is a strike-off or finishing unit. The mixing and distributing unit consists of a multiple blade maintainer, in the rear blades of which has been built a system of control gates for distributing the material from one side to the other or to the center of the strike-off unit as desired.

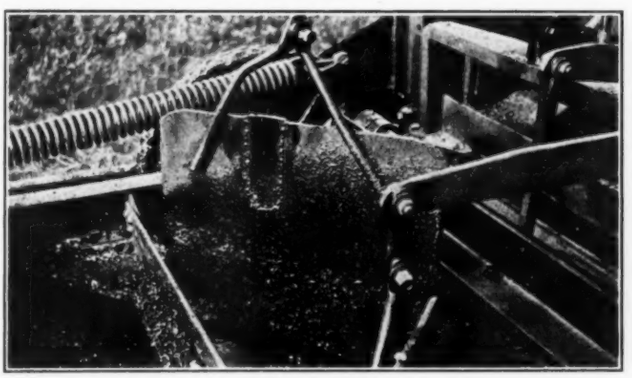
The finishing unit consists of two 20 ft. slidable forms to the center of which (spaced 10 ft. apart) has been mounted a strike-off blade, adjustable at either end. Of particular importance is the manner in which the two cooperating units are joined. The two forward ends of the forms forming a part of the strike-off unit are joined to the mixing and distributing unit by means of pins operating in slotted holes in such manner that vertical movements of the maintainer are not transmitted to the strike-off unit. Because of this manner of joining the two units, the blades of the mixing unit may rise or fall, following the vertical irregularities of the old road surface without transmitting these movements to the strike-off blade. The strike-off blade being joined to the center of the forms permits the front or rear ends of the forms to rise or fall in traveling over the irregular surface with minimum distortion of the cross section as defined by the strike-off blade and forms.

A hopper like arrangement is provided just in front of the strike-off blade so as to accommodate a considerable quantity of mixed material. Maintaining a quantity of material in front of the strike-off is necessary to take care of depressions in the old road surface and to eliminate excess crown.

The operator stands on a platform directly in the rear of the strike-off blade within ready access to all the controls, both of the mixing unit and the strike-off unit, and is in position to easily observe the required distribution of the mixed material as he looks ahead. The 20 ft. forms operating as two 20 ft. straight edges provide for an exceptionally smooth surface and also leave a straight, uniform, square edge at either side automatically.

Traffic where necessary could turn out on this spread mixture with practically no pick-up, immediately after the passage of the machine, and within an hour's time the surface was being consolidated with a roller. The second day the remaining one-half width of the entire length of the project was completed, with traffic carried over the previous day's work, and on the third day it was possible to drive over the entire surface at sixty miles an hour with no pick-up.

The cost per mile for this work was $926 which in-



Close-Up View of One of the Control Blades Which Permits Flow of Asphalt Mix to Either Side of Screed as Required

Rolling the Mix While Traffic Uses the Other Half of Road Finished the Day Before

cluded all labor, aggregate, cut-back asphalt and their application, and cost of moving equipment to the job. Equipment depreciation, repairs, insurance and interest are not included in this amount, but would of course be less than $100 per mile.

Traffic Delays Reduced to a Minimum—Traffic is very well pleased with this method of doing the work as delay is at a minimum and by placing aggregate on the surface of the road only when weather conditions are suitable, there is never any half completed work which is disagreeable for its passage. It is felt that the method of completing all operations on one-half width before doing any work on the other half is essentially sound. It is also felt that equipment should be mobilized to the extent necessary to provide for completion of all operations in one passage of the equipment rather than to have the many turnings as when the work is done with but a single blade machine. It is recognized that there are locations where this may be necessary, but for state work, where substantial mileages are ready for treatment, it is economical to so arrange work as to do it as described for this particular job, and then to move the entire equipment to another job, rather than having a number of jobs simultaneously at work with but a part of the equipment on each job. Not only is traffic better taken care of but there is an actual reduction of cost due to the development of a high morale on the work and the enthusiastic cooperation of all labor and equipment operators to see how fast and how good they can accomplish the desired results. Two complete shifts of men were employed each day on the job and as one observer commented "neither a shovel handle nor a truck steering wheel had time to get cool between shifts."

The Completed Surface

The average compacted depth of the new surface is just under 1 in. and a new treatment will not be required for another four or five years. When such new treatment is required, there will probably be nearly 50 per cent of the old material still remaining in place, so that there is cumulative value in these treatments other than a straight maintenance expenditure. Even ignoring this factor, there is an indicated cost of maintenance of the surface of less than $200 per mile, and when it is considered that the total cost of the original construction little if any exceeded $4000 for a 20 ft. width surface, the economy of such operations is readily apparent.

Much credit is due to Thomas E. Morgan, Assistant Division Engineer, who was in direct charge of the work and planned all of the personnel and aggregate distribution, and to Hugh Schwart, Division Equipment Superintendent, who designed and built the special mixing and finishing equipment and aggregate spreader used in the work.

▼

Annual Meeting National Paving Brick Association

The twenty-ninth annual meeting of the National Paving Brick Association will be held at Indianapolis, Ind., Feb. 6, 7 and 8, 1935, at the Claypool Hotel. The sessions on Feb. 7 and 8 will be open to the general public. Any one interested in street and highway development is invited to attend.

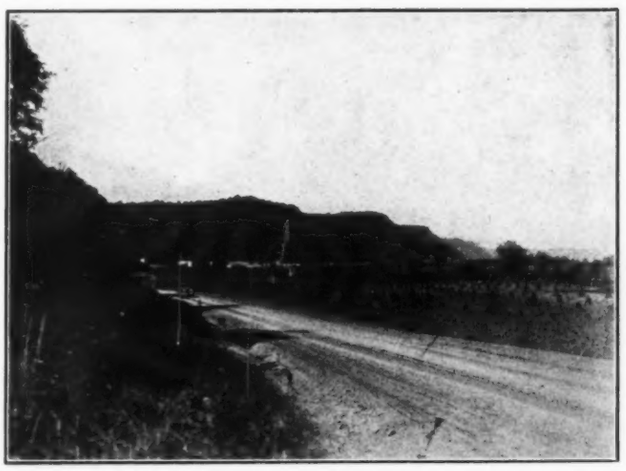
The program now under preparation will be presented by prominent engineers, contractors and paving authorities as well as manufacturers of vitrified brick to be used for paving purposes. There will be descriptions of recently constructed brick street and highway paving and resurfacing projects and a discussion of recent developments in paving brick production and utilization. Such topics as the de-airing process of manufacture, the use of the vertical fiber lug brick, and the surface removal method of filled application will be included. There will be a report from the Director of the Research Bureau maintained by the National Paving Brick Association at the Ohio State University Experiment Station. The relationship of brick pavement construction and relaying to unemployment relief and the increasing utilization of brick for resurfacing worn pavements and bases will be a prominent feature of the program.

Mr. O. W. Renkert, Metropolitan Paving Brick Co., is president, and George F. Schlesinger, formerly Director of Highways in Ohio, is chief engineer and secretary of the National Paving Brick Association. There are six member companies manufacturing paving brick with plants located in the State of Indiana.

▼

167,699 TAXING UNITS IN U. S.—According to a revised statement of the U. S. Bureau of the Census, the local government units in the United States which levy property taxes are as follows:

States	48
Counties	3,057
Cities, Villages, Towns, Buroughs	16,389
Townships	19,980
School Districts	125,627
Others	2,598
Total	167,699



The River Road, South of New Albany, Indiana, Presents an Ever-Changing Panorama of Scenes as It Winds, by Easy Curves Along the Base of the Tree-Clad Bluffs Overlooking the Beautiful Ohio River.

SCENIC HIGHWAY ALONG OHIO RIVER BUILT AS SECONDARY ROAD PROJECT

FOR farmers requiring an improved road over which to market their crops, the completion of a National Recovery secondary road, extending along the Ohio River from New Albany to New Boston, Indiana, has filled a long felt need. For the nature lover, who enjoys a scenic drive along the base of the stately bluffs which overlook the historic and beautiful Ohio River, the completion of the same project offers an opportunity to visit and explore a new section of river country which possesses a charm all of its own.

While the Ohio River was yet one of the main traffic arteries of the middle west, farmers residing along that stream between New Albany and New Boston had a convenient means of marketing the abundant crops produced on the fertile bottom acres. With the gradual abandonment of river traffic in favor of railway and highway transportation, this outlet was lost without either railways or highways being provided to take its place. And, for many years, the only means by which farmers in this particular locality had of getting their produce to the markets of New Albany and Louisville was by wagon or truck over unimproved roads, which added greatly to their delivered cost.

The counties' efforts to remedy this condition, while limited by lack of funds, resulted in partially improving what is known locally as the River Road from New Albany to Rosewood. Although this improvement was of assistance to local residents, it did not give as high a type of roadway as the traffic needs justified.

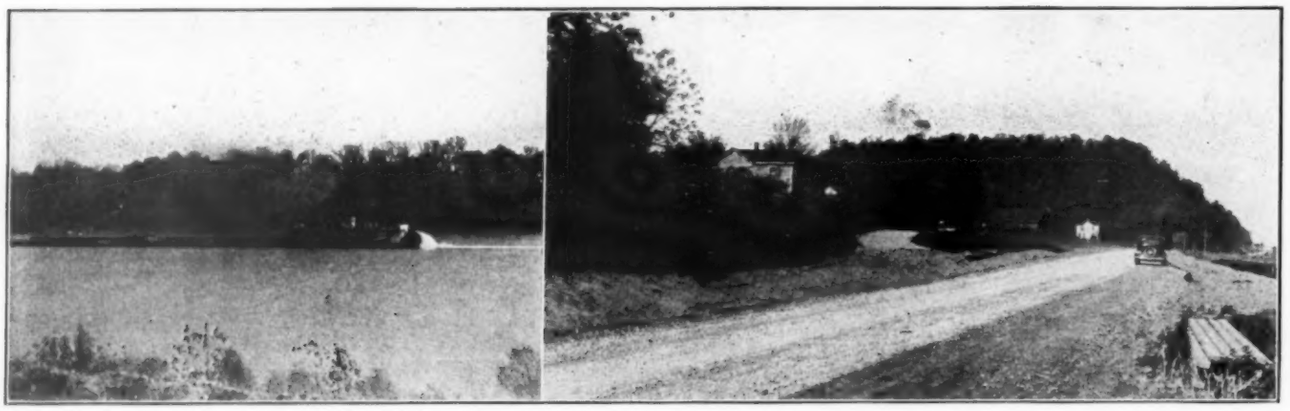
This, briefly, was the condition of affairs when the passing of the National Recovery Act made it possible to secure federal funds for the construction of badly needed secondary roads. Through the efforts of interested local parties, the approval of the River Road as a National Recovery secondary highway was secured and plans made for its construction.

These plans called for improved alignment and grade. The surface was to consist of a single course of crusher-run stone.

Where conditions warranted and their location permitted, existing bridges and culverts were repaired or extended to meet the requirements of the new highway.

Where new drainage structures were required, efforts

A 112-In. Culvert Replacing Old Bridge. In Three Days' Elapsed Time, the Old Bridge Was Demolished and Removed, and the Pipe Assembled and Backfill Completed. A Heavier Bottom Plate Paved with a Mastic Asphalt Was Used to Protect This Structure from Erosive Wear.



Three Stages of Transportation: A Sternwheeler with a Tow, Reminiscent of the Days When the River Was a Ready Outlet for the Produce of the Bottom Farmer; the Old Road Leading Off to the Left, the First Successor to "Old Man River," and the New Road on the Right Direct to the Markets of New Albany and Louisville.

were made to select a type that would meet the particular existing service conditions. Due to the proximity of the steep bluffs, run-off is very rapid. Also, because of the steepness of the grade of the streams, the water which they carry is heavily charged with abrasive material ranging in size from silt and gravel to "one man" stone. Old structures which had been in service showed the effects of this severe abrasive wear, especially in the bottom portions. To protect the new structures in the larger diameters—from 48 ins. to 72 ins.—from this destructive wearing action, corrugated pipe with the Armco paved invert was used. For the smaller diameters, where service conditions were not severe, plain corrugated pipe was used.

For two of the larger structures, where head-room was limited, 7½ ft. span Armco multi plate arches set on footings of concrete were used. To protect the footings from washing, a grouted rip rap floor was placed in these structures.

In one location, where it was necessary to replace a small bridge, sufficient head-room was available to permit the use of a 112-in. diameter multi plate pipe. To protect this structure against the wear of abrasive materials carried by the stream, the bottom plate, formed of 3-gage metal, was paved with a mastic asphalt pavement. The remainder of the pipe consisted of plain galvanized 5-gage plates.

Headwalls for all pipe and arch culverts were built of dry stone to dimensions which varied for the different sizes of pipe. The stone next to the face were selected and placed to produce a uniformly smooth surface with a minimum of voids.

Two of the Larger Structures Where Headroom Was Limited Were Replaced with Multi-Plate Arches with a Grouted Rip Rap Floor. This Particular Structure Is on a 45° Skew.

This project was completed under the supervision of the Seymour office of the Indiana State Highway Commission. All work was according to standard specifications with a reasonable tolerance allowed for secondary road construction. Arthur Siegal, New Albany, Ind., was contractor for the lower 5.7 miles. Ralph Myers of Salem, Ind., was contractor for the remainder including the widening and repairing of the black top road extending from New Albany to Locust Point.

▼

Progress on Public Works Highways

Progress made on emergency construction of public works highways to November 17 under the supervision of the U. S. Bureau of Public Roads shows a total of 560 projects, estimated to cost $30,512,000, approved but contracts not yet awarded; 580 projects, estimated to cost $21,172,000, awarded but not yet under construction; 2,656 projects, estimated to cost $166,533,000, under construction, and 6,528 projects completed at a cost of approximately $276,379,000.

The 2,656 projects under construction involve 7,552 miles of road and are giving regular direct employment to 139,100 men.

The above figures include projects involving funds provided by the Acts of June 16, 1933, and June 18, 1934.

▼

Road Transport Industries Big Employment Factor

Minnesota business houses founded wholly on needs arising from highway transportation provide jobs for one out of every six persons employed in all wholesale, retail and service establishments in the state.

The automotive, petroleum and other highway transport trades account for 12 percent of total wholesale, retail and service sales in the state, provide 15.7 percent of all jobs in this field and 16.4 percent of all payrolls.

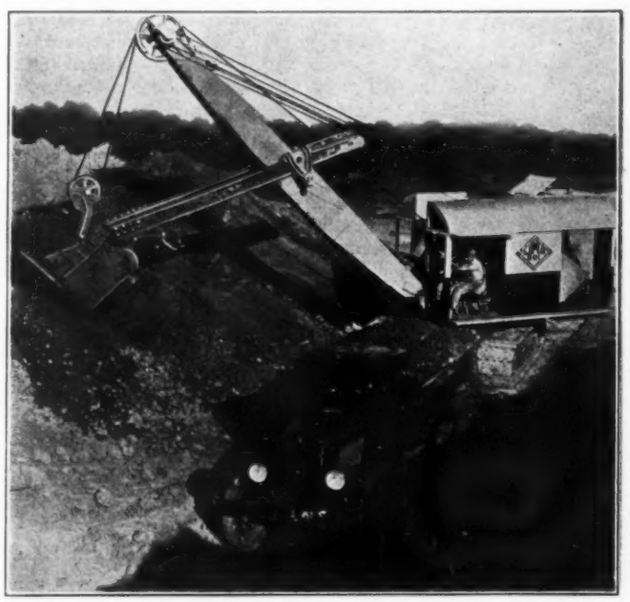
This statement of the important place of highway transportation industries in the economic life of Minnesota was developed by the National Highway Users Conference at Washington. The figures are based on statistics of the United States Census bureau for the year 1933, according to an announcement by the highway conference.

NEW EQUIPMENT AND MATERIALS

New 2-Yd. Convertible Shovel, Crane and Dragline

The Ohio Power Shovel Co., division of Lima Locomotive Works, Inc., Lima, O., builders of Lima shovels, draglines and cranes, has just announced a new 2-yd. heavy duty shovel and 35-ton crane. This new machine is designated as the Type 801, and its design embodies features that are claimed to make possible low cost yardage. It can be furnished with gasoline, Diesel or electric power.

The compact design affords exceptionally short tail swing. Only one car is required for shipment. The boom is of box type construction, electrically welded throughout—no rivets or bolts are used in its construction. The chain crowd is independent of other motions. Drums have extra large diameters, which are responsible for the remarkable cable economy. The main machinery, including cone rollers, is equipped with roller bearings. This feature promotes frictionless action, assures perfect alignment of shafts and reduces upkeep expense. All gears are helical cut for smooth, quiet and long life operation. An



Type 801 *2-Yd. Shovel*

electric starter within easy reach from the operator's position is standard equipment. All major motions are independent —an important feature when the machine is used as a crane.

The Type 801 shovel can be easily and quickly converted in the field into a dragline or crane. When equipped as a dragline it will effectively handle a 3-yd. bucket.

For complete details write for a copy of Bulletin No. 81.

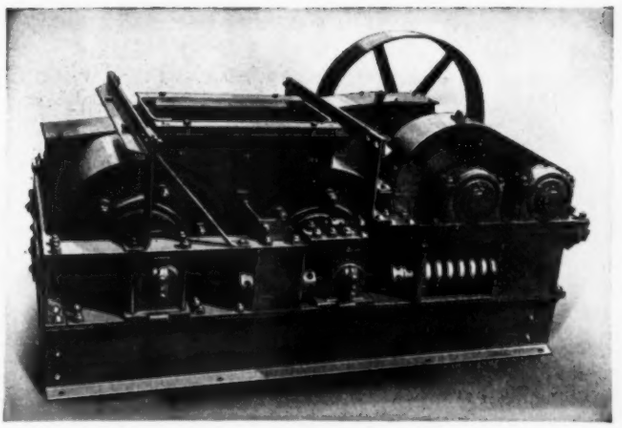
▼

New Austin-Western Roll Crusher

A new reduction roll crusher, built primarily to produce material from 1½ in. down to dust (though it will handle larger sizes) has been announced by the Austin-Western Road Machinery Co. of Aurora, Ill. According to the manufacturers, it requires less power and since it operates faster (60 R.P.M.) its capacity is therefore greater.

The rolls measure 18 in. wide by 30 in. in diameter and are equipped with 2-in. thick, removable, manganese shells. Each roll is supported by two, large SKF, self-aligning, roller bearings, that rotate on heavy stationary shafts. These bearings are located inside the rolls, close to the outer shaft supports to materially reduce shaft load.

All crusher shafts, when operating under load are subject to a certain amount of deflection which if not corrected will cause premature and excess wear or heating; such conditions



New Reduction Roll Crusher

cannot develop in this crusher because the bearings can never get out of alignment.

Two massive screws (heavy-spring equipped) permit any desired adjustment of rolls and act as safety releases against tramp iron or other unscrushable material.

Belt driven pulley shaft is geared to sprocket countershaft using heavy roller chain to operate the rolls. The chain drive permits a greater variation in the spread of the rolls, hence a greater variation of finished sizes.

Gearing, sprockets and chain are fully enclosed with heavy metal guards—Alemite lubrication is used throughout.

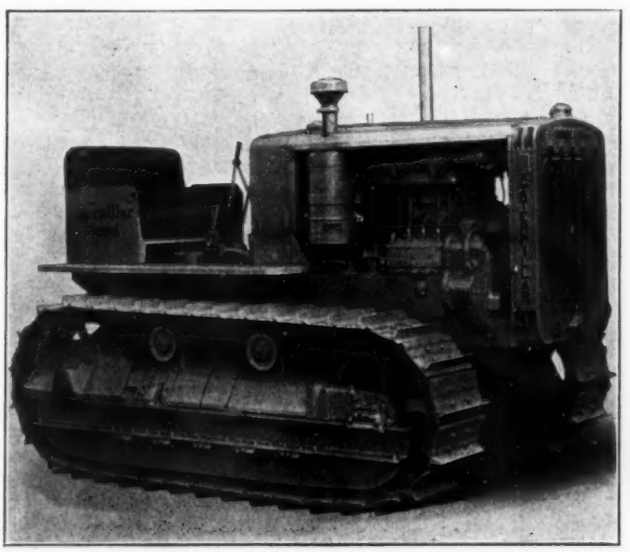
▼

"Caterpillar" Announces Diesel Forty Tractor

The Diesel Forty Tractor, recently announced by Caterpillar Tractor Co., Peoria, Ill., brings greater power, increased strength and the outstanding operating economy of the Diesel engine to a long list of tractor jobs, according to the manufacturers.

Its 3-cylinder Diesel engine develops 44 h.p. at the drawbar and 49 h.p. on the belt. The power of the engine is balanced by the strength of the machine itself, the announcement states. The track assembly and track frame feature the same rugged construction found in the largest "Caterpillar" models, including cast steel diagonal braces, enclosed recoil springs, double front idlers and heavier track links of improved design.

The Diesel Forty is built to pull a 6-8 yard wagon or a 7-8 bottom plow under most conditions. The frame is drilled for mounting such equipment as bulldozers, trailbuilders, hoists and side booms. Wide gauge models and a wide variety of track equipment are available. Shipping weight is 14,708 lbs.



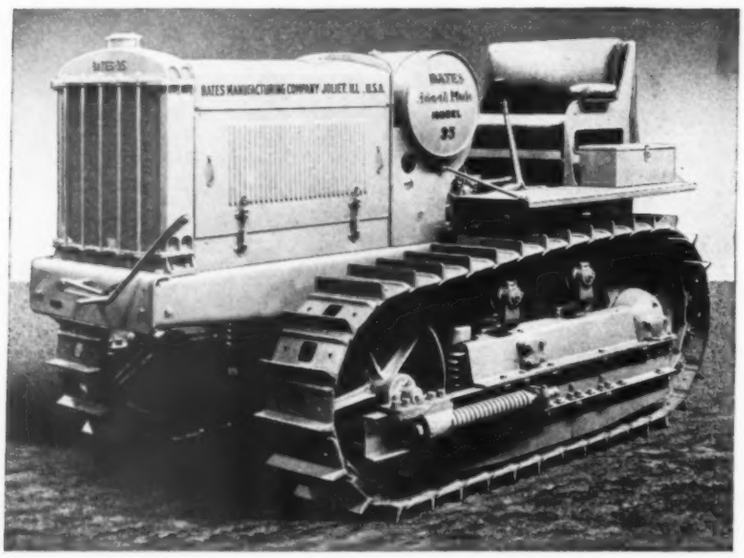
The "Caterpillar" Diesel Forty Tractor

New Tractor

The Bates Manufacturing Co. of Joliet, Ill., builders of the Bates steel mule, announce a new model 35. This new tractor incorporates all the advantages of the old Bates 35 and brings many new features.

Improved design provides greater riding comfort, greater steering ease, smoother operation and longer life. The rear end engine vibration is eliminated. This has been accomplished by a unique design for the main engine clutch and transmission. The main engine clutch contains a unique supporting feature in that the weight of the clutch parts is supported midway of two bearings. The transmission gear shaft extending from the clutch is supported on two bearings, one of which is the same bearing as is used on the clutch shaft. A gear type coupling is incorporated between the clutch shaft and transmission shaft so that the necessary flexibility is obtained between the two members and each bearing has its proportionate loading.

In the crawlers, the crawler housing supporting the track idlers has been extended to give greater protection to the drive sprocket. The wide track rail has been retained and through the installation of a specially designed electric furnace of the continuous type, uniform heat treating of track shoes has been made possible.



Bates New Model 35 Tractor

Greater clearance has been introduced between the truck wheel flanges and track rails, assuring longer wear before flange replacement is necessary.

The braking pressure of the steering brakes has been increased and the crawler can be stopped with a relatively light pressure of the foot. The standard Bates brake lock is mounted on the left-hand brake pedal.

The drag links between the steering clutch operating levers and the bell cranks on the clutches are adjustable at both ends. This permits maintaining the hand-steering lever and bell cranks in a constantly relative position regardless of the wear of the steering clutch faces, and in addition, takes up the wear of both ends of the drag link.

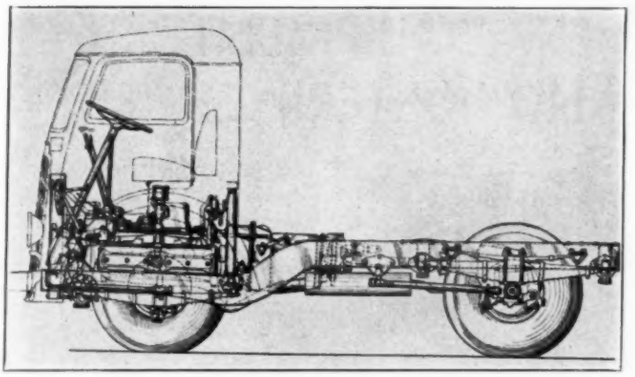
The new Bates Model 35 Tractor has a drawbar pull of slightly over 43 H.P. and can be powered for either Diesel, oil or gasoline.

▼

"Underslung Power" Trucks Announced by White Motor

An ultra-modern motor truck with "Underslung Power," is announced by The White Motor Co., Cleveland, O., for heavy duty service in city and inter-city transportation.

These new trucks are claimed to represent an entirely new principle in heavy duty hauling. White discarded all conventional practices and developed new engineering ideas to achieve these new trucks.



Drawing of Chassis of Model 731

The engine—a 12-cylinder horizontally opposed "pancake engine" is an exclusively White design and is the only one of its kind in commercial vehicles. This unique design was achieved by opening the angle of a "V" type engine so that the two banks of cylinders, containing six each, are horizontally opposed.

The engine is placed underneath the floor, with the cab moved forward to the extreme front end of the truck. Through this modern arrangement of power plant perfect weight distribution is stated to be achieved, with the lowest center of gravity, providing for greater payload space on every wheelbase.

Outstanding features include: Shortest overall length with greater maneuverability. White screwed in Stellite valve seats, interchangeable wet sleeves, dry sump lubrication, full floating rear axle, silent transmission, unusually wide tread front axle, air brakes, exceptional visibility and other safety features.

Valves are on the underside of the engine—at the lowest point of the cooling system—insure long life by eliminating the hazard of low water.

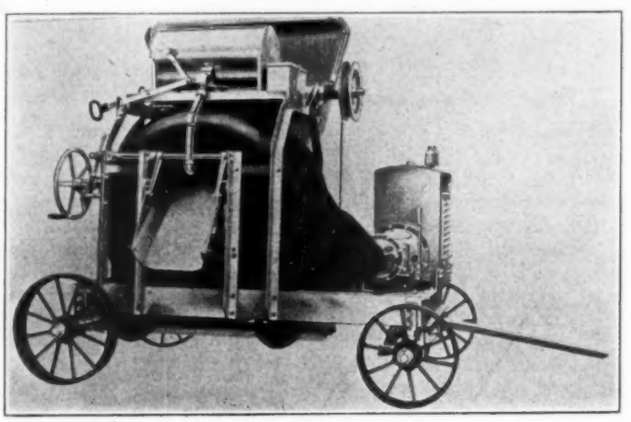
The fan is beltless, being driven directly off the end of the crankshaft, circulating cool air over the engine preventing all heat from reaching the cab. The engine is easily reached through the floor boards of the cab or quickly removed on a dolly.

This new truck is available in 24,000 to 30,000 lbs. gross weight trucks and tractor-trailer units and six wheels for heavier loads. Wheelbases range from 108 to 180 ins.

▼

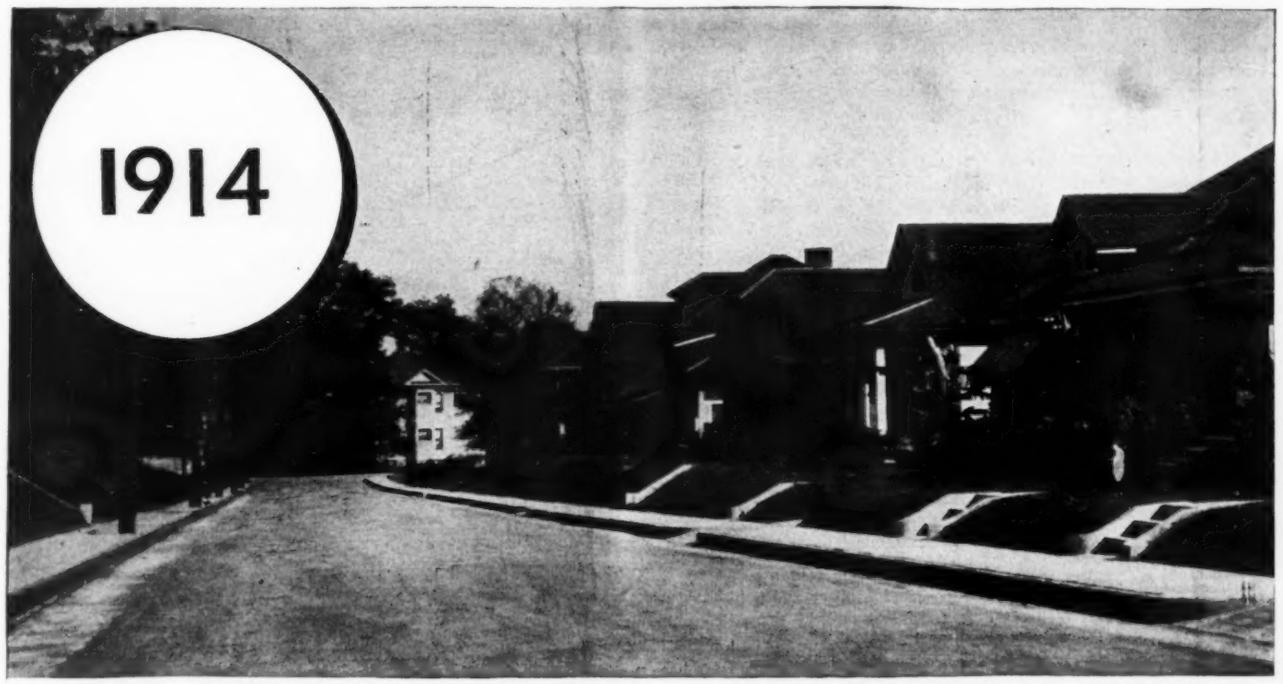
New Line of Mixers

The new line of Knickerbocker mixers, of which 7-S and 10-S sizes are announced this month, embodies design features said to assure unusually thorough mixing combined with rapid handling of dry materials and mixed concrete.



Knickerbocker 48 Degree Discharge Pitch

Harbert Street, Memphis, Tennessee. Tarvia-built in 1914, the year the World War began in Europe. The lower photo shows the condition of Harbert Street today.



● **The confidence of road officials and engineers in the lasting economy, traffic-safety and ride-ability of Tarvia roads is expressed in the hundreds of miles of these famous roads that are built each year. At the close of 1934, The Barrett Company thanks the many users of Tarvia for this encouraging vote of confidence. Tarvia, the close and helpful cooperation of skilled Tarvia field men, and Barrett's unmatched facilities for prompt and dependable delivery service are ready to serve you again in 1935. 'Phone, wire or write our nearest office.**

Barrett
Tarvia
GOOD ROADS AT LOW COST

THE BARRETT COMPANY
New York Chicago Philadelphia Cleveland Birmingham St. Louis Detroit Minneapolis
Toledo Milwaukee Lebanon Baltimore Columbus Youngstown Boston Buffalo Providence Syracuse Hartford Cincinnati
Bethlehem Rochester Portland, Me. In Canada: THE BARRETT COMPANY, LTD. Montreal Toronto Winnipeg Vancouver

The drum is of large diameter and the distance from opening to opening comparatively short. The manufacturers, The Knickerbocker Co., Jackson, Mich., point out that the 60 deg. loading skip is the steepest ever offered and is made possible by the largest charging opening ever designed for similar sized power loading mixers. This combination facilitates rapid charging. Skip pounding and shaking are stated to be eliminated.

Once in the drum, the materials are subjected to the traditional Knickerbocker re-mixing action, which has been improved and refined. The materials are cut and folded by blades and carried by buckets to the top of the drum, whence they spill onto the discharge chute which, in mixing position, acts as a deflector, returning the mass to the charging side of the drum, where the folding and kneading action is repeated. The wide discharge chute, in discharge position, assumes a 48 deg. angle which results in emptying the drum almost instantly.

The complete operating cycle—charge, mix and discharge—is claimed to make possible a batch schedule profitably timed from the contractor's standpoint. The unusual speed of the first and third phases allows ample time for the mixing period, to satisfy the most rigid engineering requirements.

The low center of gravity on these machines makes for stability. Concealed and protected coil springs in the truck frame, with three-point suspension, absorb road shocks.

▼

Low Ground Pressure Features New Dragline

Low ground pressure is the outstanding feature of the new P & H Model 750-LC dragline of the Harnischfeger Corporation, Milwaukee, Wis., designed primarily for work on irrigation and drainage jobs where soft ground is encountered.

The constant manipulation of mats commonly required to provide solid footing takes time and costs money by cutting

New P & H Model 750-LC Dragline

heavily into the day's yardage. This fact moved P & H engineers to provide this machine with "mud shoes." Length of crawler has been increased to 15 ft. 9¼ in. Crawler shoes are 42 in. wide, resulting in a reduction of ground pressure to only 7.3 lbs. per square inch—extremely low for a 2-yd. machine.

The exceptionally long corduroys are securely mounted on massive through axles. Traction is provided through a simplified chain drive with fully machined gears enclosed to protect them from dirt and obstructions.

In other respects, the new 750-LC conforms to standard P & H design, with "sure feel" power clutch, "trigger" dipper trip, and other split second features.

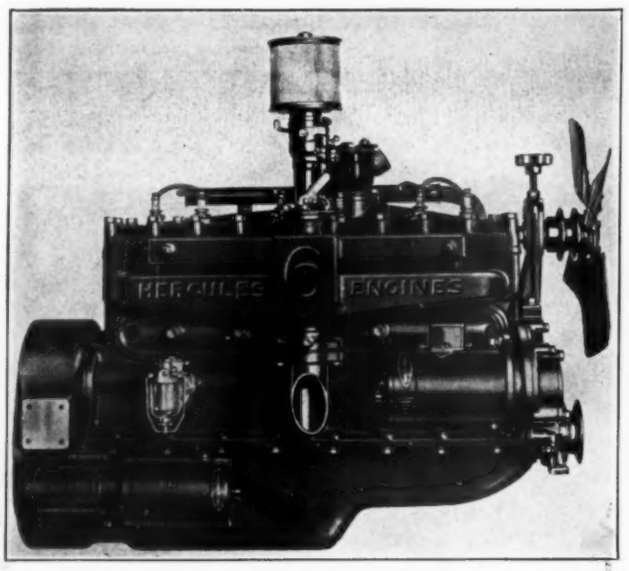
▼

New 6-Cylinder Gasoline Engine

The Hercules Motors Corporation of Canton, O., has added a larger bore model to their "JX" series of 6-cylinder gasoline engines. This the "JXD" 4x4¼-in., 320 cu. in. displacement.

This engine develops 83.8 HP. at 2,800 R.P.M. and 65.5 HP. at 1,800 R.P.M. with maximum torque of 204 ft. lbs. at 1,000 R.P.M. (N. A. C. C. Rating 38.4 HP.). A 2½-in. chrome molybdenum crankshift is supported by seven bearings of the high lead bronze precision type. The cylinder and crankcase are cast integral of molybdenum alloy iron. Cylinder head is detachable, the "L" head design being fitted with exhaust valves 1⅜-in. clear diameter—inlet valves 1½-in. clear diameter.

Lubrication is forced feed by geared pump to all connecting rod and main bearings, oil thrown off from the rods lubricating the cylinder walls. Aluminum alloy pistons are fitted with four rings all above the piston pins—an oil control ring 3/16 in. wide and three compression rings ⅛ in. wide.



Hercules JXD Engine

A four bearing camshaft located on the right-hand side of engine looking from flywheel has all cams forged integral.

All connecting rod bearings of high lead bronze precision type are 2 in. in diameter, the length of rod being 8 in. from center to center. Either a 1¼-in. or 1½-in. carburetor can be installed, and a distributor mounting is provided on left-hand side where the centrifugal water pump is also mounted. A magneto mounting is available as optional equipment.

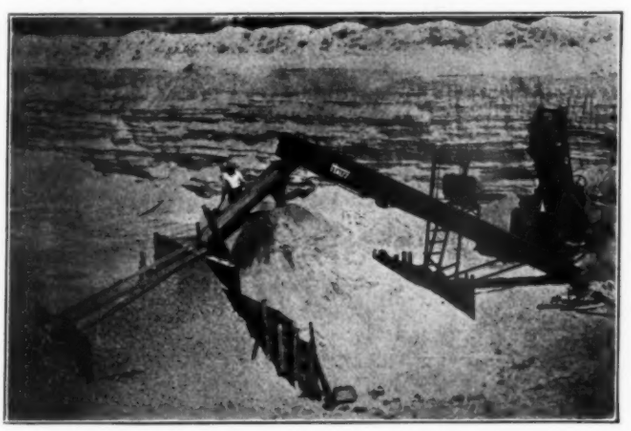
This "JXD" is supplied with No. 3, No. 4 or No. 5 bell-housing for 3 or 4-point suspension and flywheels for any standard clutch.

▼

Haiss Portable Belt Conveyors Redesigned

The George Haiss Mfg. Co., New York, has redesigned and revamped the construction of its portable belt conveyors which it has been building over a period of 15 years. Such advances in design consists of rubber lagged head pulley on the coal machines, Timken tail pulleys and overhead raising and lowering device which gives a greater latitude from the load to the high position. The conveyor belt is a 4-ply rubber, ⅛-in. top rubber covering and 1/32-in. lower rubber covering. The rubber edges are also ⅛ in. thick. It has a tensile strength of approximately 2,000 to 2,300 lbs. to the square inch. The compound used between the plys of duck has a friction of 16 to 18 lbs.

On the Haiss troughing type conveyor, the tail pulley runs



Haiss Belt Conveyor at a Sand and Gravel Plant

FOR MORE WORK MORE TRIPS AND GREATER PROFIT

THE GMC T-33 TRUCK IN THE 3-TON RANGE

Look where they will and compare as they wish, buyers of trucks in the 3-ton capacity range can make no better selection than the General Motors T-33. In every detail of its rugged make-up, this "engineered-for-the-job" money maker challenges on the score of downright value. *In fact, not one truck in its capacity range matches the T-33 on more than 3 of the 12 important counts that definitely assure greater performance, increased economy and longer life*—counts such as high sustained torque, frame stiffness, payload capacity and valve-in-head performance, to list but a few.

Pages could be devoted to a description of T-33 superiorities, but the most convincing way to judge its merit is to call in a General Motors Truck representative and ask to be shown the truck itself and the facts to prove why this staunch worker and earner is every inch an exceptional value at its comparatively low price—a far greater value than any other truck of comparable size.

● Whatever your hauling needs may be, there's a GMC truck or trailer to fit exactly—capacities range from 1½ to 22 tons.

GENERAL MOTORS TRUCKS AND TRAILERS

GENERAL MOTORS TRUCK COMPANY
PONTIAC, MICHIGAN
Time Payments Available Through Our Own Y. M. A. C.

in Hyatt bearings equipped with hydraulic Zerk fittings. Such conveyors are mounted with a new type of overhead raising frame and can be equipped with steel wheels, rubber tired wheels, also swivel axles when desired. The illustration shows the Haiss belt conveyor at a Long Island plant being loaded by means of a Haiss creeper loader elevating the sand to a screen where the sand falls from the gravel and discharges over the end.

New Trailer Arc Welder

Universal Power Corporation, Cleveland, O., in developing their new Ford V-8 motor driven, 300 ampere arc welder of high speed portable trailer type, have used the Staidarc prin-

Universal New Trailer Arc Welder

ciple for arc stabilization, similar to that used in their motor generator sets.

The combination of the Staidarc welder coupled with the smooth flow of power of the Ford V-8 motor, has effected a gas driven arc welder performance of unusual stability and flexibility. The unit is mounted on two wheel "donut" tires.

Universal High Speed road trailer arc welders are claimed to have many features contributing to their usefulness and efficiency. The novel mountings of the horizontal radiator directly over the engine, with blower type fan, materially effects the cooling of the entire unit. A sliding cover over the radiator allows for proper amount of radiation and cooling regardless of temperature conditions.

All-Purpose Industrial Tractor

A new all-purpose industrial tractor, "Clarktor-6," in three models, has been announced by Clark Tructractor Co., Battle Creek, Mich.

"Clarktor-6" has a 46 h.p. 6-cylinder power plant. Heavy duty Clark transmission and special gear ratios in double reduction rear axle make a wide range of speeds available to handle various types of service—speeds as high as 18 m.p.h. This is important in construction operations covering large acreage where speed has an important bearing on the tractor's earning capacity. All models have self-starter, generator, battery, electric horn, front bumper plate, eye coupler, pneumatic tires. Lights are available on all models, to facilitate night operation. Gas power makes 24-hour uninterrupted service possible. Included in the extra equipment available are dual pneumatic or solid tires, special couplers, Clark condensing muffler, speedometer, front fenders.

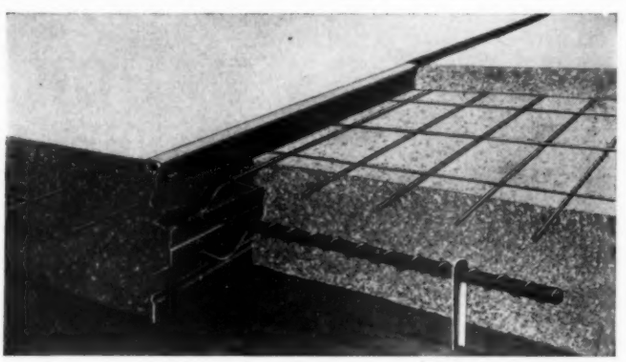
New "Clarktor-6"

New Contraction Plate for Concrete Roads

An expanded contraction plate has been developed recently by the Tuscon Steel Co., Youngstown, O., for providing a definite plane of weakness in the pavement that forms a straight, regular crack when the concrete slab expands or contracts. In concrete road construction the contraction plate is used in combination with the reinforcing steel. The plates are placed transversely at regular intervals, and longitudinally down the center of the slab.

For transverse joints the contraction plates are placed with the top edge from ½ to 1 in. below the surface of the finished road. The concrete is poured in the regular way, completely covering the plates, and there is no interference with the finishing, whether by machine or hand.

The Truscon expanded contraction plates are rolled from steel plates that are rigid, substantial and easy to handle. The dowel



Truscon Expanded Contraction Plate

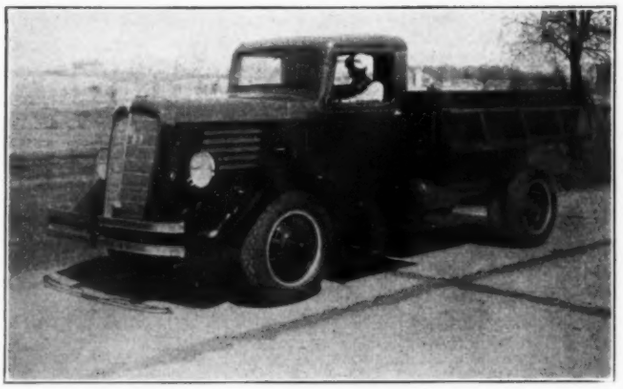
in the plate dovetails the adjacent sections of concrete slabs. The plates are either pinned to the subgrade by means of steel stakes or by use of the improved installing devices which eliminate the necessity of the stakes. The plates are properly punched for dowel bars on 5-ft. centers and are fastened continuously end to end by means of the Truscon clip.

New 1½-Ton High-Speed Truck

Combining beauty and graceful lines with the high horsepower used in their entire line of trucks, the Four Wheel Drive Auto Co. of Clintonville, Wis., has developed a new ton-and-a-half speed truck which they have designated as Model HS. Their engineers have directed special attention to speed, sturdiness, ease of steering, smoothness of riding, reliability, and safety on the road. The specifications call for a road speed of 47 miles per hour, with full load.

The new model is propelled by an 84 HP. engine which develops 185 foot-pounds torque. The fundamental principle of applying power equally to all four wheels, which is used in all previous models of the Four Wheel Drive Auto Co.'s line, is retained in the new model HS. Each of steering and simple handling is increased by setting the front axle back 42½ in. from the front bumper. The HS model employs this setback-of-front-axle principle also to secure equal distribution of load. This new entry in the truck field is built for heavy duty as well as fast traveling. The 6.50-20 tires are dual in the rear.

The new speed truck is convertible from an all-four-wheel drive to front-wheel drive or rear-wheel-drive—in cases of emergency. The chassis weighs 5,220 lbs. including the cab. The gross weight is 11,200 lbs.



New Model HS 1½-Ton Truck

Wheelbase, and body space back of the cab, are made variable according to the demands and needs of the purchaser. Thus with a 132-in. wheelbase, 120 ins. of clear space for load is available back of the cab, while a 121-in. wheelbase gives 96 ins. of body space, and 142-in. wheelbase allows 144 ins. for load use.

The power-plant consists of an FWD six-cylinder BK type engine. The patented, built-in governor is adjustable, sealed, self-lubricating, and non-hunting. A seven-bearing crankshaft, battery ignition, wire-mesh type of air-cleaner and mechanical fuel feed gives the engine smooth-running sturdiness.

The FWD engineers, seeking long life of the engine, have provided a forced water circulation by means of a centrifugal pump through a fin-and-tube radiator, and a full-pressure system for oil distribution, equipped with a series type of oil filter.

The power from the engine is transmitted to the four-speeds-ahead transmission through a 12-in. plate clutch, and from the transmission main shaft level the power is transferred to the center differential where it is divided and distributed to each axle. Compensation for the difference in distance traveled by the front and rear axles is solved by a conventional bevel-gear type of center differential. The center differential lock, patented by the FWD Co., operates from the driver's seat.

Complete control of this speed-truck is maintained through four-wheel hydraulic brakes operated by a vacuum booster.

▼

New Snow Plow

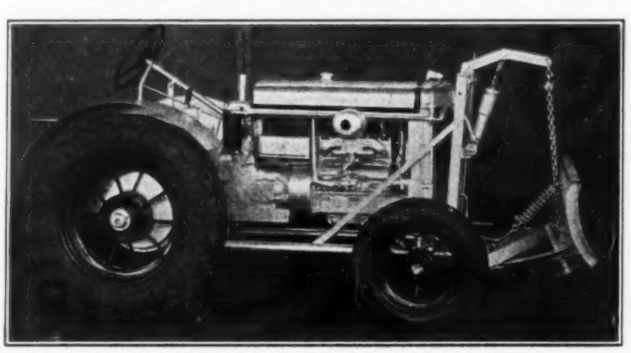
A new snow plow that pushes the snow from the rear axle of the tractor instead of from the front end only has been brought out by the Fate-Root-Heath Co., Plymouth, O. Heavy high carbon steel push bars extend back under the tractor and connect as near the point of power as possible.

Other important features claimed for the plow are:

When in operation, the snow plow rides on adjustable chilled shoes, thus enabling the blade to be set at any desired distance from the pavement.

The blade can be set at any desired angle and can quickly be reversed to throw the snow to either the right or left.

A simple tripping device consisting of one heavy compres-



Silver King Snow Plow

Specify

TRINIDASCO

—cold-laid Asphalt Pavements

Trinidasco—the Native Lake asphalt mixture that is laid cold—is prepared with the same grades of stone, sand and other mineral aggregate and Trinidad Lake Asphalt used since 1876 in the construction of standard types of Trinidad hot-mix pavements.

Trinidad is the safest asphalt for durability. Trinidasco cold-laid pavements have a high coefficient of friction, and are safe for modern traffic.

Trinidasco cold-laid pavements are used for new construction . . . for resurfacing . . . for maintenance. Trinidasco is convenient . . . can be laid with hand tools or mechanical devices immediately after preparation, or from stock piles.

Specifications and full particulars covering mixtures for asphaltic concrete, asphalt macadam and sheet asphalt (binder and top) pavements furnished on request.

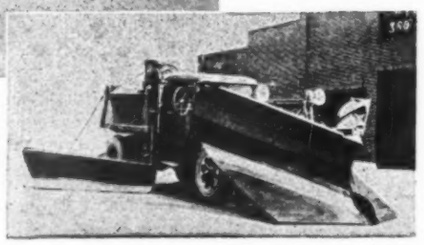
THE BARBER ASPHALT COMPANY

NRA MEMBER U.S. WE DO OUR PART

Philadelphia

New York **Chicago** **St. Louis**

A Size For Every Motor Truck



Either Manual or Hydraulic Control

FRINK SNO-PLOWS

CARL H. FRINK, MFR.

CLAYTON, 1000 ISLANDS NEW YORK

Davenport Locomotive & Mfg. Corp.
Davenport, Iowa

Frink Sno-Plows of Canada, Ltd.
Toronto, Ontario

BLAW-KNOX BUCKETS

It is a waste of money to handle dead, unnecessary bucket weight on your crane. Blaw-Knox Bucket Engineers can show you how to get the most economical tonnage out of your crane equipment.

Don't hesitate to ask for this valuable advice.

BLAW-KNOX COMPANY · 2003 FARMERS BANK BLDG.
Pittsburgh, Pa. . . . Offices and Representatives in Principal Cities

BLAW-KNOX

sion spring can be adjusted so as to allow the blade to pass over obstructions without damage.

To gain maximum strength, the frame and push bars of the Silver King snow plow are constructed of high carbon steel while the blade is of special steel reinforced with six perpendicular ribs and a horizontal heavy steel angle running across the bottom of the blade.

The cutting blade is made of special steel and, being reversible, gives double service.

All controls are hydraulic and are operated from the seat of the tractor.

▼

Two Stage Compressors Added to Schramm Line

Schramm, Inc., of West Chester, Pa., have announced the addition of a complete line of two stage portable compressors to their line of single stage machines.

The one outstanding characteristic of the two stage outfit is the fact that many parts are interchangeable with the single stage compressor permitting the user to utilize many of the parts which he may already have on hand for servicing the new design.

The greatest efficiency has been secured by piping air from the first stage through a cross-flow type intercooler into the second stage which gives the air the final compression before entering the air receiver. The Schramm two stage compressor is stated to eliminate many unnecessary packings, pipings and fittings and result in a compact, straightline design, all moving parts being in perfect mechanical balance and easily accessible for servicing.

Schramm Two Stage Compressor.

The vertical, water cooled design is again used in the Schramm two stage compressor.

These new, two stage Schramm compressors are built in four popular sizes (Models 105, 160, 210 and 315) with either gasoline or Diesel engine drive, and are available in all types of portable mountings, including wooden skid mounting, steel wheels, rubber tired wheels, Schramm spring trailer, two wheel trailer, motor truck mounting, rail car mounting, etc.

A new bulletin 3501 (BS) describing the new two stage compressor as well as the complete line can be secured by writing to Schramm, Inc., West Chester, Pa.

▼

New Dipper Trip and Tag Line Winder

A new dipper and tag line winder for power shovels has been announced by The Morin Mfg. Co., Holyoke, Mass. This new Type H has the following improvements:

Larger rear bearing, bronze bushing in front and rear bearing with a large grease reservoir around the bushing, new type of thrust cap which completely encloses the end of the shaft and keeps lubrication in and dirt and grit out. The thrust cap is provided with a hardened steel thrust bushing and thrust screw. All thrust on this dipper trip is taken care of with ball thrust bearings. The drum is provided with an Oilite bushing with large oil reservoir around the bushing and felt oil retainer. This dipper trip is also constructed so that it is impossible for any oil to get in the friction disc. The hub on the friction disc extends into the end of the drum. This hub is provided with oil throwing off edge which will throw off any oil which may leak out of the drum bushing. The friction disc is provided with 36 large radiating fins which keep the discs comparatively cool when the machine is used for tag line winding.

WITH THE MANUFACTURERS

More Than 1,000 Attend P&H "Open House"

More than 1,000 visitors, including many important industrial executives, engineers and technicians from throughout the Mid-West area, were open house guests of the Harnischfeger Corporation at Milwaukee on Nov. 17, an occasion which marked the high spot of the company's 50th anniversary celebration.

Among the interesting features of the afternoon's program was the exhibition of the newest P&H models going at top speed on the test field adjoining the plant. Here, visitors had an opportunity to see the smallest P&H model, a ⅜-yd. gasoline shovel, operating beside the largest model, a 4 cu. yd. Ward Leonard electric drive. A 3½-yd. Diesel powered dragline added its share to this ground churning jubilee.

Also were shown the four 300-ton electric cranes just completed in the Harnischfeger shops for the United States Government for installation at Boulder Dam. These units, which will comprise the largest single power house crane installation on record, will be used for handling the mammoth 600-ton hydro-electric rotor generators, the largest of their kind ever built.

▼

Organization Changes in Hercules Explosives Department

The following changes in organization in the Explosives Department, Hercules Powder Co., to become effective Jan. 1, 1935, have been announced by C. A. Bigelow, general manager of the department: John K. McCabe, now assistant manager of the San Francisco office, has been made an assistant director of sales with offices in Wilmington, Del. J. B. Johnson, for the past five years superintendent at Hercules, Calif., has been named to succeed Mr. McCabe as assistant manager of the San Francisco office.

▼

Timken Appointments

The Timken Roller Bearing Co. announces the appointment of Whitley B. Moore to the position of general manager of the Industrial Division. Mr. Moore, who is a mechanical engineer, was graduated from the University of Michigan in 1918, going immediately into service in the U. S. Navy. At the close of the war he joined the engineering staff of the Timken Roller Bearing Co. He soon became interested in the selling phase of engineering and became associated with the Timken sales engineering staff, where his work quickly received recognition.

John L. Young, until recently district general manager in charge of the Pittsburgh office of the company, has been advanced to the position of assistant general manager of the Industrial Division and will move to Canton, O., to take over his new duties in the near future. Mr. Young joined the Timken organization in 1921.

Harry D. Robb, who has been with the company since 1925 on sales engineering work in various territories, has been advanced to the position of district manager in charge of the Pittsburgh office, succeeding John L. Young, who has been transferred to the Canton office.

Harry H. Wood, who has been on engineering and sales staff in Canton since 1929, specializing in the application of Timken bearings in steel mills, has been transferred to Pittsburgh, and appointed manager of the Rolling Mill Division.

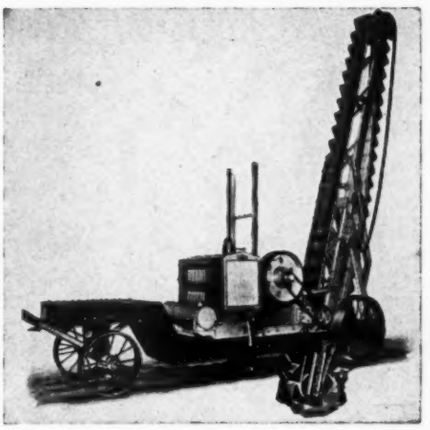
▼

Pickett Appointed Advertising Manager Toncan Culvert Manufacturers' Association

In line with the policy to coordinate even more closely the activities of the Toncan Culvert Manufacturers' Association with the expanding needs of its member companies and to concentrate its organization at the Youngstown office, the association announces the appointment of Mr. H. N. Pickett as advertising manager.

For a number of years Mr. Pickett has been advertising manager of Daily Metal Trade, one of the leading market papers of the iron, steel and metal working industry. His direct association with industrial advertising and publishing covers a period of more than twenty years. It is felt that his

the famous Forty-Niner



leads the way in '34

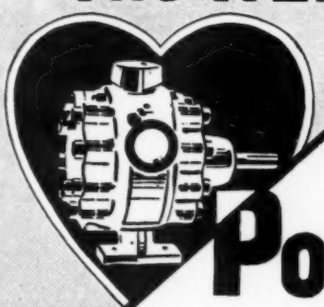
Climaxing a long line of improvements, Gruendler now offers to the road builders of today the latest type of portable crushing unit—the famous FORTY-NINER. This modern outfit, including a truck-mounted crusher and elevator, sets a new standard in crushing machinery. It represents the sum total of Gruendler experience and progress since 1885.

Write for the new Bulletin which gives complete details of the Gruendler Forty-Niner, Straight Line Crushing and Screening Plants, Gravel Screening and Crushing Plant

GRUENDLER
CRUSHER & PULVERIZER CO.
2915 North Market St., Dept. RS.
ST. LOUIS, MO.

ROPER

The HEART



of Power

Pressure Pumps for Hydraulic Applications

A complete line for elevators, scrapers, drags, snow plows, bull-dozers, tilting concrete mixers. Sizes, capacities and mountings to meet every requirement. Pressures up to 750 lbs. Write for bulletin No. R-5-R.

We also build Pumps for handling tar, asphaltum, etc.

Geo. D. Roper Corporation - Rockford, Illinois

DEPENDABLE **PUMPS** SINCE 1857

CUT THE COST OF WINTER OPERATIONS WITH

J. & S.

PATENTED

TRACTION TREADS

Here is the Equipment you need NOW for your Dual Tired Trucks, Tractors, Motor Graders, etc.

J & S TRACTION TREADS will put every ounce of Engine Power into your Tractor Wheels in Mud, Sand, or Snow and Ice.

Easily attached with positive adjustable lock, which compensates for tire wear and tire variation.

J & S TRACTION TREADS are made in two style shoes, with grouters integral as shown or with quick detachable grouters.

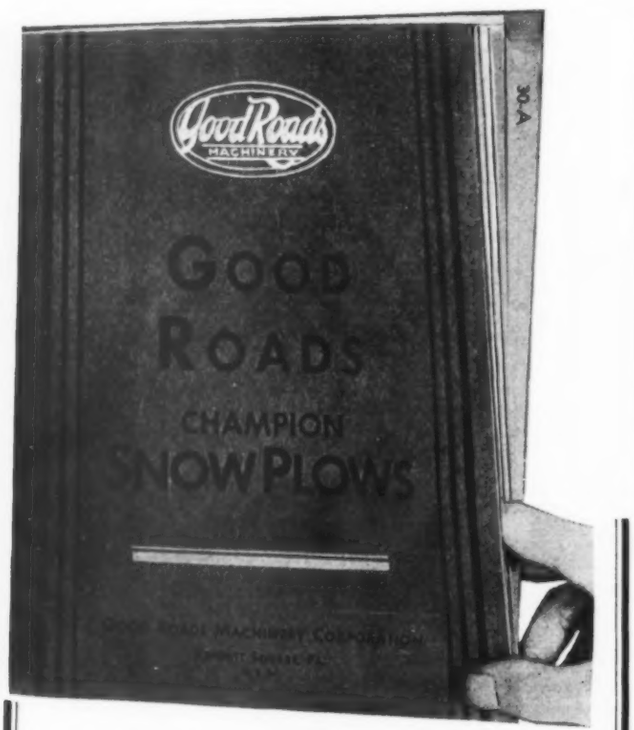
Shoes are made of special wear-resisting heat-treated steel. Pins and Connecting Links are special alloy steel and hardened.

J & S TRACTION TREADS do not injure tires but protect them. Made to fit all sizes of Dual Pneumatic Tires. Write for prices, addressing your inquiry to Department B.

MANUFACTURED BY

W. A. RIDDELL COMPANY

BUCYRUS · · OHIO



THIS is Catalog No. 53!
Did YOU get a copy?
If not, send for it NOW.

appointment as advertising manager of the Toncan Culvert Manufacturers' Association will enable it to cooperate still further with the member companies in their sales of Toncan iron corrugated pipe and sectional plate pipe throughout the country.

▼

Scene-in-Action Advertising Company in Big Expansion Program

Plans that call for the most vigorous campaign in the history of Scene-in-action effects in the fields of window and counter displays, convention, trade show and exposition exhibits, decorative effects for theaters, restaurants, clubs, etc., sales demonstration material and outdoor bulletin boards, has called for a complete reorganization of the production, creative and sales programs of the Scene-in-action Advertising Co., manufacturers of Scene-in-action effects.

This campaign for a new invasion of the Point of Purchase Display world is intended to strengthen the position which Scene-in-action Displays so sensationally achieved some years ago, when this unique combination of color, light and movement was first introduced.

Under the supervision of A. B. Leech, originator of Scene-in-action effects, who is serving the company as technical director, new, improved developments will shortly be introduced to materially widen the scope of the organization's activities. These, according to Mr. Leech, will bring Scene-in-action possibilities within the range of practical application by thousands of concerns, and compete in point of economy with many types of inanimate displays.

M. F. Flanagan, new general manager of the company, is a well-known Chicago advertising and merchandising man, who comes to the position from the advertising agency field. He brings to bear on the duties of general manager a wide experience with the intimate problems of manufacturers and others in sales promotion and dealer work.

For the benefit of the Eastern territory, the new expansion program of the Scene-in-action Advertising Co. includes the establishment of a New York office, under the management of R. L. Barker. This office is already open at 420 Lexington Ave. Plans are nearly complete also for representation on the West Coast and other important centers in the United States, as well as Canada. Advertising of the company will include a large list of trade and class publications, and an extensive direct mail campaign. The production and creative departments, and the general offices of the company will be concentrated in their plant at 18th St. and Indiana Ave., Chicago.

▼

Furlong Now District Sales Manager for Federal Truck

J. F. Bowman, vice-president in charge of sales of the Federal Motor Truck Co. of Detroit, has announced the appointment of Don G. Furlong to the position of district sales manager. Mr. Furlong is well known in motor truck circles. For nine years he was associated with the Ford Motor Company Sales Division. The last five years he was in charge of the Commercial Truck Division of the Dearborn Branch. Before that time his duties with the Ford Motor Co. took in dealer and salesman supervision, operation and maintenance of sales and service training schools, and contacting and developing truck and fleet operators. In the spring of 1933 Mr. Furlong left the Ford organization to go with the Thornton Tandem Co., Detroit, as general sales manager. He remained with this company for a year and a half. His work here involved the developing of a national sales outlet through distributors of special equipment for commercial trucks. Mr. Furlong will cover the Ohio territory for Federal where he is well acquainted with the trade.

▼

Working Now District Sales Manager for Republic

Appointment of Robert J. Working as district sales manager in Cincinnati for Republic Steel Corporation has been announced by N. J. Clarke, vice-president in charge of sales. Mr. Working succeeds W. A. Peck as head of the Cincinnati office. Formerly in the sales department of United Alloy Steel Corp. at Canton, Ohio, Mr. Working was placed in charge of the Cincinnati district office of the Central Alloy Steel Corp. in 1927. Following the Republic merger in 1930 he was made assistant district sales manager of the Cincinnati office.

SAUERMAN LONG RANGE MACHINES

Reach Any Distance up to 1,500 ft.

• • •

Dig Deep; Dump High

• • •

Low Operating Cost

• • •

Handle From 100 to 5,000 cu. yds. a day.

Sauerman Slacklines and Drag Scrapers are money-savers for the many projects that require movement of materials beyond the reach of power shovels, revolving draglines and other short range machines. Write for catalog.

SAUERMAN BROS., 488 S. Clinton St., Chicago

REDUCE DIRT MOVING COSTS

THE BLAW-KNOX HYDRAULIC

BULLDOZER

The Blaw-Knox (Ateco) Hydraulic BULLDOZER moves more dirt at less cost. Yardage costs go down. Hydraulic power, two-way control, rigid box type construction. If you are interested in lowering your dirt moving and grading costs, send for Catalog No. 1394.

Complete line of Blaw-Knox Dirt Moving Machinery includes the Blaw-Knox Dirtmover, Sheepsfoot Tamping Rollers, Scarifiers, Clamshell and Dragline Buckets.

Blaw-Knox Company
2003 FARMERS BANK BLDG., PITTSBURGH

BLAW-KNOX

Etnyre OREGON ILL.

BITUMINOUS DISTRIBUTORS

—that meet all State and County specifications.

—that operate efficiently.

—that give years of trouble-free service.

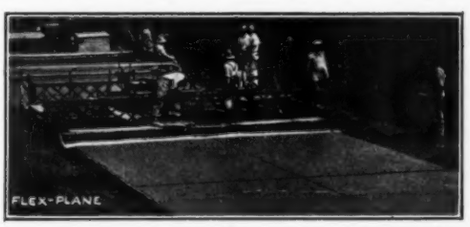
You will find them in the ETNYRE Line.

Please send for further information.

E. D. ETNYRE & COMPANY

DEALERS IN ALL PRINCIPAL CITIES
400 JEFFERSON ST. OREGON, ILL.

"Flex-Plane Contraction Joints"



Correctly spaced and installed control cracking, prolong the life and improve the appearance of concrete roads. Flexible contraction joints are rapidly and economically installed mechanically by the FLEX-PLANE machines.

Installers Leased by

FLEXIBLE ROAD JOINT MACHINE COMPANY, Warren, Ohio

JAEGER *Automatic* PUMPS

- Prime Faster
- Pump More Water,
- Pump More Hours

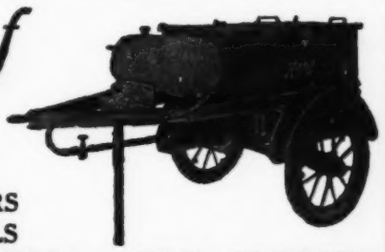
2", 3", 4", 6", 8" sizes. Capacities 10,000 to 125,000 g.p.h.

THE JAEGER MACHINE CO.
223 Dublin Ave.
Columbus, Ohio

8" 125,000 G.P.H.

Hotstuf

TRADE MARK



ASPHALT HEATERS
TOOL HEATERS
PAVING TOOLS
SURFACE HEATERS — TOOL TRAILERS
POURING POTS, ASPHALT SPRAY PUMPS

Dealers in Principal Cities

MOHAWK ASPHALT HEATER CO.
Frankfort New York

PORTABLE ASPHALT PLANTS

TOWER TYPE

LARGE CAPACITIES
HOT OR COLD MIX

Accurate control of materials to comply with any standard specifications for bituminous mixtures.

Send for Bulletin T-246

HETHERINGTON AND BERNER INC
Indianapolis, Indiana

True Indiana Hospitality
at
HOFFMANN
SYSTEM HOTELS

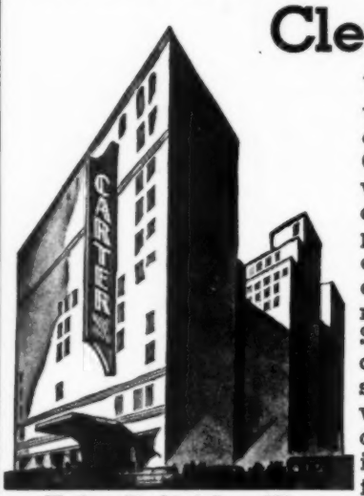
THE NEW
HOFFMANN
Newest in the city
Every room with radio
Combination tub & shower
RATES FROM $2.50 UP
Also Furnished Apartments

LA SALLE HOTEL
400 Rooms from $2.
LA SALLE
ANNEX
ALL ROOMS WITH BATH $1.75 ALL ONE PRICE
300 Car Fireproof Garage in Connection
Serves all 3 Hotels

Another HOFFMANN HOTEL *The* FORT ARMSTRONG *at* Rock Island Illinois

SOUTH BEND
INDIANA

When You Come to Cleveland



The Carter Hotel, in the heart of Cleveland is conveniently located close to leading department stores, theatres, banks and transportation terminals.
Room Rates Begin at $2.50

When next you visit Cleveland come to the New Carter Hotel. A warm welcome awaits you—prompt, courteous service and delicious food at reasonable prices. Six hundred large, comfortable outside rooms each with private bath and circulating ice water. Exceptional facilities for conventions and sales meetings. Personalized management.

The **CARTER HOTEL**
PROSPECT NEAR EAST NINTH
CLEVELAND, OHIO
WILLIAM T. CRUSE, Manager

Bellevue-Stratford

The traditional hospitality of the Bellevue is a subject for reminiscence wherever men gather, the world over. Recent complete modernization in decoration and appointments have added even a fresher note to this famous hotel.

Rates as low as $3.50

CLAUDE H. BENNETT
General Manager

IN THE HEART OF PHILADELPHIA

Old-fashioned Hospitality awaits you at—
BARLUM HOTEL

810 OUTSIDE ROOMS
Each with tub and shower bath
$2. A DAY
A few at $2.50 and up
CADILLAC SQUARE at BATES STREET

DETROIT

ROADS and Road Construction

A MONTHLY RECORD OF ROAD ENGINEERING AND DEVELOPMENT.

"ROADS & ROAD CONSTRUCTION" circulates amongst Surveyors, Road Engineers, Municipal Authorities and those engaged in Road Development in all its branches throughout the world.

REGULAR FEATURES EACH MONTH:

Technical Articles dealing comprehensively with the subjects of Road Construction and maintenance, Bridge design and building and all engineering problems connected therewith.

Foreign Road Construction.
Latest Patents and Trade Marks.
Road Materials and Plant (including Transport Vehicles).
New companies.

SUBSCRIPTION 20 PER ANNUM
INCLUDING
YEAR BOOK and DIRECTORY

THE CARRIERS PUBLISHING CO., LTD.
BANGOR HOUSE, 68/9 SHOE LANE E. C. 4

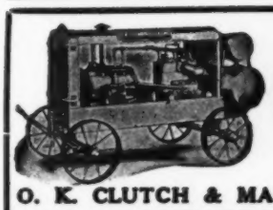
RELIANCE CRUSHING SCREENING and WASHING EQUIPMENT

Backed by 30 Years of Experience

CRUSHERS SWEEPERS
ELEVATORS SPREADERS
CONVEYORS WASH BOXES
SCREENS FEEDERS

Complete Portable and Stationary Plants
Consult Us Before Buying

UNIVERSAL ROAD MACHINERY CO.
KINGSTON, N. Y.
New York Office—114 Liberty Street



O.K. Compressors and Hoists

Write for Bulletins

O. K. CLUTCH & MACHINERY CO., Columbia, Pa.

TAR HEATERS
PORTABLE AND STATIONARY

See Page 94 Road and Street Catalog or write

THE JOS. HONHORST COMPANY
1016 W. 6th Street Cincinnati, Ohio

PROPOSALS

New Orleans, October 26, 1934.

Sealed proposals will be received by the Sewerage & Water Board of New Orleans, at the office of the Purchasing Agent, Room 502,, No. 526 Carondelet St., New Orleans, up to 12 o'clock, noon (C. S. T.) of the dates indicated below, for the following construction contracts, which constitute P. W. A. Project No. 4284:

GROUP "A"—Bids to be opened

December 27, 1934.

216-D Deepening and widening Orleans Outfall Canal from Drge. Stn. 7 to Lake Pontchartrain.

217-D Concrete lining and covering of Almonaster Ave. Canal from N. Roman St. to Florida Ave.

218-D Furnishing and laying pipe line in St. Charles Ave. from Lee Circle to Felicity St.

115-S Furnishing and installing sewers in area bounded by Industrial Canal, St. Bernard Parish, St. Claude Ave. and Claiborne Ave.

116-S Furnishing and installing sewers in Algiers, between the S. P. R. R. Yards and Farregut St.

201-W Furnishing cast iron water pipe and appurtenances.

202-W Installing water mains in Algiers, Gentilly Road, etc.

128-D Furnishing underground power cable.

129-D Installing underground power cable from Stn. D to Stn. 3; and from Stn. D to Stn. 5.

132-D Hauling underground power cable.

GROUP "B"—Bids to be opened

January 3, 1935.

219-D Lined and covered drainage canal and pipe line in S. Claiborne Ave. from Nashville Ave. to Leonidas St.

220-D Concrete pipe lines in South and North Olympia St. between Orleans and Banks Sts., in Murat St. between Palmyra and Banks St., in Banks St. between Olympia St. and S. Carrollton Ave., and in St. Claude St. between Poland and Japonica Sts.

130-D Installation of underground power cable from Power House 2 to Stn. 1; from Stn. 1 to Stn. 2 and from Power House 2 to Stn. 6.

GROUP "C"—Bids to be opened

January 10, 1935.

221-D Lined and covered drainage canal and pipe lines in Lamarque, Whitney, Numa and Genl. Meyer Ave. from Stn. 8 to Saux Lane.

222-D Concrete lined and covered canal in Genl. Taylor St. from Broad to Willow Sts.

223-D Drainage pipe line in Jefferson Ave. from S. Claiborne Ave. to McKenna St.

203-W Furnishing cast iron water pipe and appurtenances.

204-W Installing 30-in. water mains in Magnolia and other streets.

131-D Installing underground cable from Stn. 3 to Stn. 7 and from Stn. 7 to Stn. 6.

GROUP "D"—Bids to be opened

January 17, 1935.

224-D Partly lining and partly widening and deepening London Ave. Outfall Canal from Stn. 3 to Lake Pontchartrain; and lining and covering Broad St. Canal from Bruxelles St. to Stn. 3.

Plans and specifications may be obtained at the office of the Board on and after November 27, 1934. A payment of $5.00 will be required for each set of plans and specifications issued for each contract. Not less than minimum wage rates established by P. W. A. must be paid and all bids accompanied by certificate of compliance with applicable code, or, if none, with President's Re-employment Agreement.

A. G. MOFFAT, Secretary. BRYSON VALLAS, Gen'l Supt.

CLEARING HOUSE

TRANSITS AND LEVELS

Largest stock in UNITED STATES of guaranteed **Rebuilt Transits** and **Levels** for RENT (with purchase option) or for SALE (on easy payment plan if desired). Every instrument repaired in our own factory. Sold subject to field test.

Complete and economical REPAIRS to your instrument regardless of make — by expert **instrument makers.** Shipping container on request. Estimates free. Your instrument deserves factory service.

Write for new descriptive list and rental schedule RS-812

WARREN-KNIGHT CO.
Makers of Sterling Surveying Instruments
Headquarters for Field Equipment and Drafting Room Supplies
136 N. 12th Street, Phila., Pa.

TRANSITS—LEVELS

All makes—all sizes—repaired and regraduated by Factory Experts. The finest work at the LOWEST POSSIBLE COST. Unusually good instruments for sale or rent. Reliability and guaranteed work. A special Souvenir Plumb Bob sent gratis to graduate Civil Engineers.

M. L. McALLISTER
327 Lamartine St., Boston 30, Mass.

EMPLOYMENT SERVICE

POSITION WANTED

EXPERIENCED sales and promotion engineer desires position with manufacturer who is interested in increasing sales. Acquainted with highway contractors, engineers, and state, county and municipal officials in Virginia and North and South Carolina. Minimum salary required until ability is proved. Address Box 170, Roads and Streets, 400 West Madison St., Chicago.

Theo. DeWitt Says—

NOW...

In TOLEDO It's
THE NEW
HOTEL SECOR
Completely Renovized and Re-equipped
POPULAR PRICED
Coffee Shop
AND
Parisian Cocktail Bar

RATES FROM $2.50

SAVE time and money in New York!

The Piccadilly is "close to everything." Ninety per cent of your calls are within a few minutes' radius of this new hotel, and its short-cut location will save time (and taxi fare) in covering the town.

And when you need relaxation, you are right in the center of theatres and amusements . . . to say nothing of the Piccadilly's own "Silver Lining" Cocktail Room . . . *Perfect.* De luxe dinner and supper, with dancing in the Georgian Room, for one dollar!

RATES FROM
$2.50
ROOM WITH BATH—450 Outside Rooms

HOTEL PICCADILLY

227 West 45th St.
Now Under Arthur Lee Direction

IN CHICAGO

Auditorium hotel rooms are large, spacious and comfortable with beds that were really made for restful slumber.

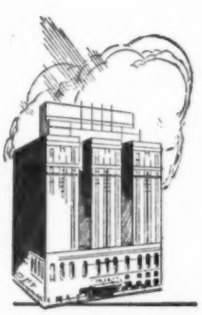
WITH PRIVATE BATH FROM $2.50
WITHOUT PRIVATE BATH – $1.50

Live on Michigan Avenue, close to the Loop, when you visit Chicago. Enjoy the traditional luxury of the Auditorium Hotel–yours now at an extremely moderate cost.

AUDITORIUM Hotel

MICHIGAN AVENUE AT CONGRESS ST.

...HAVE YOU HEARD *the one about the traveling salesman?*



He went to bed at the William Penn and slept twenty years! Well, maybe that is a little exaggerated. But anyway, the beds at Pittsburgh's number one hotel are so comfortable you don't ever want to get up. The food in the four famous restaurants is equally exceptional, and the prices reasonable. Quiet, well-furnished rooms, $3.50 single; $5.00 double, all with bath.

1600 ROOMS . 1600 BATHS

HOTEL WILLIAM PENN

PITTSBURGH, PENNA.

Yes—We would like you to mention ROADS AND STREETS.

DIRECTORY OF ENGINEERS

Aerial Mapping Since 1922

ABRAMS AERIAL SURVEY CORP.

Contractor to Federal, State, County and Municipal Government Depts., Large Corporations—Private and Industrial Interests

WE HAVE MAPPED FROM THE AIR 61 MUNICIPALITIES
AN ENGINEERING SERVICE CONTINUED AERIAL SURVEY MAPS
Highways, Transmission Lines, Pipe Lines, City Zoning and Tax Maps, Timber Cruises.

Send for our Folder—"The Third Dimension in Aerial Photography"

Submit Projects for Contract Prices — Lansing, Michigan

Alvord, Burdick & Howson

Engineers

John W. Alvord, Charles B. Burdick, Louis R. Howson, Donald H. Maxwell.
Water Works, Water Purification, Flood Relief, Sewerage, Sewage Disposal, Drainage, Appraisals, Power Generation.
Civic Opera Building, Chicago.

C. M. Baker

Consulting Engineer

Specializing in Industrial Waste Utilization and Stream Pollution Problems.
Investigations, Reports, Estimates.
2 So. Carroll St.,
Madison, Wis.

Black & Veatch

Consulting Engineers

Sewerage, Sewage Disposal, Water Supply, Water Purification, Electric Lighting, Power Plants, Valuations, Special Investigations, Reports and Laboratory.
E. B. Black, N. T. Veatch, Jr.
Mutual Bldg.,
Kansas City, Mo.

Burns & McDonnell Engineering Co.

McDonnell-Smith-Baldwin-Lambert

Consulting Engineers

Waterworks Sewerage
Lighting Appraisals
Rate Investigations
Kansas City, Mo., 107 W. Linwood Blvd.
Western Pacific Bldg., Los Angeles, Cal.
Dixie Terminal Bldg., Cincinnati, Ohio.

The J. N. Chester Engrs.

J. N. Chester
J. F. La Boon
D. E. Davis
J. T. Campbell
E. B. Bankson

Consulting Hydraulic, Sanitary and Valuation Engineers.
Clark Bldg., Pittsburgh, Pa.

Chicago Testing Laboratory, Inc.

and affiliated

Chicago Paving Laboratory, Inc.

Consulting and Inspecting Engineers

Hugh W. Skidmore
Gene Abson
Materials, Processes, Structures, Consultation, Inspection, Testing, Design, Research, Investigation and Experts in Litigation.
536 Lake Shore Drive, Chicago.

H. Burdett Cleveland

Consulting Sanitary Engineer

Water Supply and Purification, Sewerage and Sewage Disposal, Refuse Disposal, Treatment of Industrial Wastes, Design, Reports, Consultation, Investigation, Evaluation of Works, Supervision of Construction.
90 Wall St.,
New York City.

G. Gale Dixon

Consulting Engineer

Water Works—Sewerage.
Home Savings and Loan Bldg.,
Youngstown, Ohio.

Fowler, Charles Evan

Consulting Civil Engineer

M. I. Am. C. E.
M. Eng. Inst., Can.
BRIDGES AND ARTISTIC STRUCTURES.
FINANCING FOR GOOD PROJECTS.
5 West 63rd St., New York.

Fuller & McClintock

Engineers

F. G. Cunningham
C. A. Emerson, Jr.
Elmer G. Manahan
W. Donaldson
Ernest W. Whitlock
H. K. Gatley
Sewage Treatment, Sewers, Waterworks, Water Purification, Drainage, Waste Disposal, Valuations.
11 Park Place, New York

Nicholas S. Hill, Jr.

Consulting Engineer

Water Supply, Sewage Disposal, Hydraulic Developments, Reports, Investigations, Valuations, Rates, Design, Construction, Operation, Management, Chemical and Biological Laboratories.
112 East 19th St., New York.

A. Elliott Kimberly

Consulting Sanitary Engineer

Water Supply, Water Purification, Water Softening, Sewerage, Sewage Disposal, Sewage Treatment, Waste Treatment. Specialists in Milk and in Canning Waste Treatment.
568 East Broad St., Columbus, Ohio.

Morris Knowles, Inc.

Engineers

Water Supply and Purification, Sewerage and Sewage Disposal, Valuations, Laboratory, City Planning.
Pittsburgh, Pa.

Metcalf & Eddy

Engineers

Water, Sewage, Drainage, Refuse and Industrial Wastes Problems, Laboratory, Valuations.
Statler Bldg., Boston.

Malcolm Pirnie

Engineer

Water Supply, Treatment, Sewerage Reports, Plans, Estimates.
Supervision and Operation. Valuation and Rates.
25 W. 43rd St., New York, N. Y.

Potter, Alexander, C. E.

Hydraulic Engineer and Sanitary Expert

Sewerage and Sewage Disposal, Water Supply and Purification.
50 Church St., New York.

Sheppard T. Powell

Chemical Engineer

Treatment of Water for Industrial Uses.
Trade Waste Investigations and Correction.
Technical Expert in Litigations.
330 N. Charles St.,
Baltimore, Maryland.

Astrid S. Rosing, Inc.

Sewer Pipe.
Drain Tile.
Steam and Electric Conduits.
Building Tile.
Fire Brick.
2417 Orchard St.,
Chicago, Ill.

P. H. Taylor Audit Co.

Municipal Accountants and Auditors

Audits.
Systems.
Budget Preparation.
Investigations.
267 Highland Ave., Buffalo, N. Y.

Whitman & Howard

Harry W. Clark

Associate Engineers
(Est. 1869—Inc. 1924)
Channing Howard
Paul F. Howard
Walter A. Janvrin
C. Roger Pearson
Water Supply, Water Purification, Sewerage, Sewage Disposal, Water Front Improvements and all Municipal and Industrial Development Problems. Investigations, Reports, Designs, Supervision, Valuations.
89 Broad St., Boston, Mass.

P. S. Wilson

Consultant in Sanitary and Hydraulic Engineering.
Water Works Management.
Glen Ridge, N. J.

at your

ELBOW

the accumulated experience of many engineers, contractors and builders throughout the nation—

The Methods and Cost Library

These 5 Books for Constant Reference

Volume I
Gillette's Handbook of Construction Cost
1734 Pages, 4½x7. Illustrated
Price $6

Volume II
Dana's
Handbook of Construction Equipment
New Second Edition
349 Pages, 4½x7. Illustrated
Price $6

Volume III
Gillette & Dana's
Handbook of Mechanical and Electrical Cost Data
Over 1500 Pages, 4½x7. Illustrated
Price $6

Volume IV
Gillette's Handbook of Cost Data
1854 Pages, 4½x7. Illustrated
Price $6

Volume V
Conner's Labor Costs of Construction
200 Pages, 5x3¼
Price $3.

Gillette's "Construction Cost Keeping and Management" standard treatise on organizing business for economy and profit; 572 pages. Without charge when you decide to keep the library. $5.00.

This Book FREE

The Value of this library can be fully realized in only one way—at your elbow, accessible for reference as job succeeds job in your own experience. We know this from the reports of contractors and engineers who date the growth of their business prosperity from their first reference to these volumes.

Thus, we do not ask you to buy them first and learn their value afterward. We offer to put them at your elbow free of charge for a trial. Use them. Get the flavor of their helpful counsel. Check your own habits in figuring costs or selecting methods, in comparison with the general standard practice among builders everywhere.

After you skim through the broad subject headings at the right, send the coupon.

This List of Subjects Covered

Engineering Economics — Prices and Wages—Hauling—Excavation Economics — Standpipes — Concrete Construction—Dams—Reservoirs, and Water Works—Water Treatment Plants — Irrigation — Land Drainage—Sewers—Garbage Disposal—Roads and Pavements—Bridges and Culverts — Steam Railways and Tunnels—Docks and Wharves—Electric Motors—Lights —Miscellaneous Costs—Earth Excavation and Transportation — Rock Excavation—Steel Piling and Cofferdams—Wood and Concrete Piles — Concrete Costs — Concrete Form Costs—Steel Reinforcing—Structural Steel—Timber Work—Rough and Finish Carpenter Work—Brick and Tile—Masonry — Plastering and Plumbing — Painting—Sewers—Water Works —Concrete and Other Paving Costs—Equipment and General Labor Expense.

Gillette Publishing Company
Technical Publishers
400 W. Madison St.
Chicago, Illinois

Gillette Publishing Co.,
400 W. Madison St., Chicago, Ill.

Please send the Methods and Costs Library, postpaid, for examination. In 10 days I will remit $6.00 in part payment and keep the books, or I will return them postpaid. If I keep them you agree to send me a free copy of "Cost Keeping and Management." I will send $4 a month for 5 months until the full price of $26.00 is paid.

Name .....

Firm .....

Address .....

City..... State.....R & S-12-24

Books sent on approval in U. S. and Canada only.

$32.00 Library
with this coupon
$26.00